Metal Treating

SEPTEMBER
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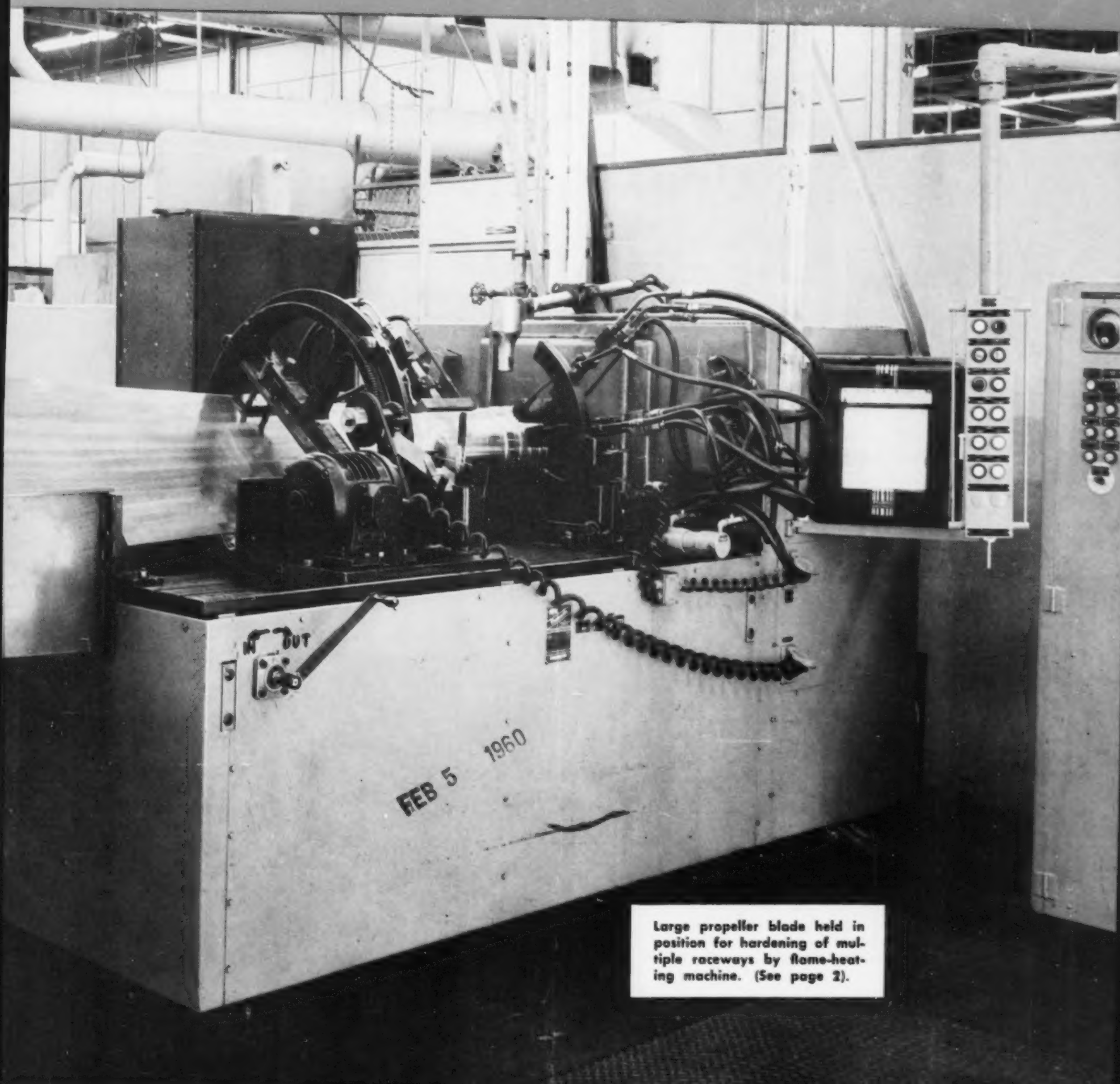
THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY



Large propeller blade held in position for hardening of multiple raceways by flame-heating machine. (See page 2).

EIGHTH ANNIVERSARY ISSUE

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HARDENING OF MULTIPLE PROPELLER BLADE RACEWAYS

By **GORDON G. JOHNSON,** Selective Heating Engineer,
Hamilton Standard Division,
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THE PROPELLERS on today's aircraft are the result of a great deal of engineering skill and effort—aeronautical, mechanical, metallurgical and chemical. They are complete with various mechanical improvements, and are designed to provide faster, safer and more comfortable travel by air.

Aircraft propellers, such as those designed, developed and manufactured at Hamilton Standard Division of United Aircraft Corporation, are, for example, equipped with hydraulic mechanisms which provide for quick-acting constant speed, and permit reversing of the blade thrust to act as a brake in checking forward speed and to bring about shorter, safer and smoother landings. Such blades also are electrically de-iced. On multi-engine aircraft the propeller blades are automatically synchronized to turn at identical revolutions per minute, and are electronically synchophased so that the propellers will turn at a specific relationship to one another and at a desired relative angle to the fuselage.

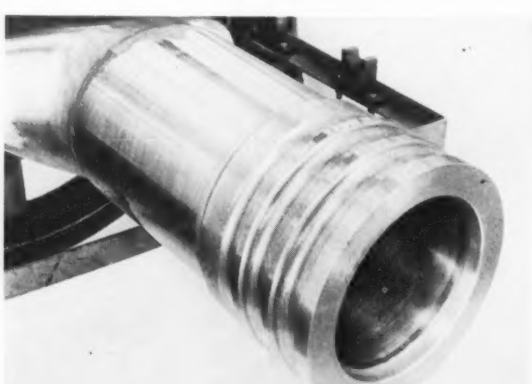

Fig. 1—Propeller blade retentions in close-up, on loading stand preparatory to loading on flame heating machine.

The sensitive mechanisms required for these manifold duties call for a strong propeller hub which will permit quick response of the blades to the pilot's commands.

In order to hold the propeller blades of the hollow steel type within the propeller hubs and to promote smooth turning of the blades to meet requirements of varying flight conditions, each blade rotates on ball bearings carried in raceways at the shank end of the blade. The multiple raceways in Hamilton Standard blade shanks are being hardened by a special flame-heating machine designed and manufactured by the Meta-Dynamics Division of the Cincinnati Milling Machine Co.

The Flamatic consists of two parts—a basic machine with a quench tank, and a control cabinet. The basic machine is ten feet long, exclusive of splash guard extensions. It is five and one-half feet wide; 68 inches high at the spindle end; and 42 inches high at the opposite end.

The control cabinet, measuring 73 by 58 inches and 33 inches deep, is a separate unit providing regulated pressure control for fuel gas, oxygen and air and water. Furthermore, the cabinet is so designed that the heat flow may be easily changed to accommodate various sizes of areas which require hardening.

Hamilton Standard's Flamatic was designed primarily for the hardening of cylindrical surfaces, specifically the ball retentions of steel propeller blades. The machine provides the flexibility needed to harden simultaneously from three to five raceways on propeller blades ranging from five to ten feet in length and weighing up to several hundred pounds. All sizes of propeller blades

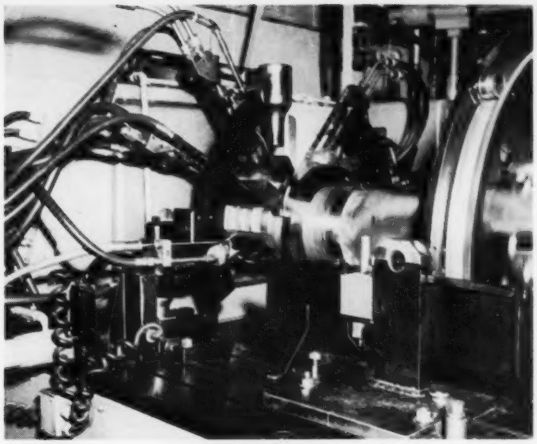

Fig. 2—Close-up view of rotating blade retentions just prior to flame ignition. Ray-O-Tube, temperature sensing unit, also is visible.

have been processed, from the small four-race, two-shank blade to the large five-race, eight-shank blade. In hardening a blade of the latter proportions, the flame machine is operating at approximately 80 percent of its capacity.

The ball retentions of the blade are heated while the blade is being revolved on a horizontal axis. Support of the blade during this phase of the cycle occurs at the butt face by a clamping action on the airfoil area of the propeller blade at the leading and trailing edges. Rotation of the blade for heating purposes is accomplished by means of a cage-type wheel, the revolving member of which is clamped to the airfoil area and driven by an electric motor through a gear arrangement.

Specific heating time is determined automatically by a precise electronic control device which measures the temperature of the work surface. When the pre-set temperature has been reached, the flames are automatically extinguished. Upon completion of the heating phase, the support at the retention end of the blade is retracted, and the adjustable trunion-type fixture holding the blade pivots to a vertical position thus allowing the blade retentions to become submerged in the high-speed quenching oil.

In the quench oil tank is a steam control which raises the cold oil to quenching temperature; a thermostatically-controlled heat exchanger, and a quench oil agitator. The agitator is adjustable so that work pieces of varying sizes can be quenched directly in the center of the agitated area. The blade retention remains submerged in the oil until its temperature has dropped within the range of 200 to 300°F. Quenching time ranges from eight to ten minutes, depending upon the part.

The quench oil is heated to the desired quenching temperature by saturated steam, and is maintained at the desired temperature by thermostatic control in conjunction with a water-cooled heat exchanger. The oil temperature for Hamilton Standard operations is kept in the vicinity of 140°F (±10°). Agitation of the quench oil occurs during the entire period in which the machine is in operation. This provides a more uniform cooling of the part in the quenching phase of the hardening process. The quench oil tank capacity, at the overflow drain line, is 450 gallons.

After the quenching operation, the blade is removed from the holding fixture and the retention end of the blade is placed in an oven for the purpose of relieving post-hardening stresses within this end of the blade. The stress relief temperature used is dependent on the minimum case hardness required.

The duration of the heat applied to the part to be hardened is determined by experimentation, after which a timer or a radiation pyrometer is used to control automatically the sequence of operations. The radiation pyrometer is utilized in conjunction with a temperature recorder-controller and gives a relative temperature indication. If the pyrometer gun, called a Ray-O-Tube, is aimed at the same relative area as each part being treated, fairly accurate repetition of thermal energy in-put may be expected. The Ray-O-

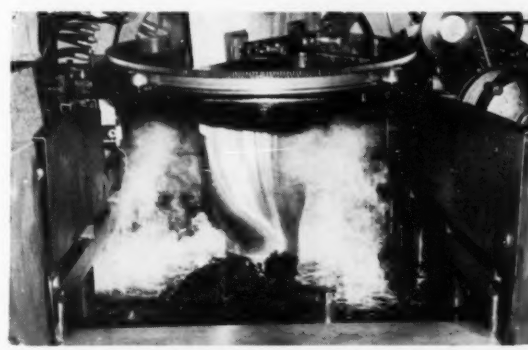

Fig. 3—Propeller blade in quench position, showing agitation of oil around submerged portion of blade.

Tube, which is a temperature sensing unit, is mounted on the spindle end of the machine.

The flame machine is equipped with six blow pipes, feeding six specially-designed 75-tip, rhomboid-type flame heads. Each flame head is made up of three rows of 25 tips each. The rhomboid design allows spacing which in turn permits (in spin hardening) flame impingement on the work piece every one-eighth inch. When more than one flame head is used, the adaptability is such that spacing between lines of flame impingement can be reduced to 1/32 of an inch. The flame tips and plug are of the screw-in variety. This facilitates rapid changes in the flow of heat as required in order to bring about the desired hardness pattern. Flame tips are made in various lengths so that tip patterns may be set up to conform to the periphery of the work piece.

(Continued on page 67)

VACUUM HEAT TREATING

By **RICHARD L. HOFF,** Development Metallurgist

Superior Tube Company
Norristown, Pa.

MANAGEMENT, shop people and even some engineers are beginning to understand the application of vacuum equipment. Because of the growing interest in vacuum heat treating, it seems worthwhile to consider (1) which alloys are being vacuum heat treated, (2) how these alloys are vacuum heat treated, and (3) what happens when this is done. Because there are now a large number of manufacturers of vacuum heat treating equipment who will be glad to submit all sorts of literature and quotations on equipment available, the type of equipment and use will be covered briefly while more attention will be given to offering comments which may be of help if you are thinking of adapting such equipment for your own applications.

Management Aspect:
(Which alloys are being vacuum heat treated?)

For the future, the prospects for alloys to be vacuum heat treated are those which are melted under vacuum in the first place. Production of the reactive metals, titanium and zirconium, has been growing rapidly. Production of titanium this year is estimated to approximate 14 million pounds, while that of zirconium will be somewhere in the neighborhood of 750 thousand pounds with a likelihood of a three-fold increase within two years. Despite the publicity given to the reactive metals, the quantity of vacuum melted iron-base and nickel-base alloys including the super alloys is rapidly soaring to a level of five or six times the total of the reactive metals.

From the standpoint of vacuum heat treating, the ability of vacuum to remove hydrogen from titanium alloys (called *degassing*), has been well proved during the past four years. Degassing has actually been achieved successfully on full sized 12-inch ingots as well as on finished parts as thin as .010″. This is one aspect of vacuum heat treatment. From the aspect of annealing, there is an increased tendency on the part of all the titanium and zirconium fabricators to use vacuum annealing for all sections under one-eighth of an inch thick and sometimes one-quarter of an inch in thickness. Vacuum annealing can most certainly be used satisfactorily on stainless steels and nickel-base alloys. The use of vacuum annealing for these materials is a question of economics, since the use of vacuum is a batch heat treatment while in many cases these alloys can be annealed in continuous and controlled atmosphere furnaces at a lower cost. We have used vacuum annealing on high carbon steel and on alloy steel without any effect whatsoever upon the carbon content. This is a technical advantage not to be overlooked.

Another use for vacuum heat treatment is in aging or precipitation heat treatments. In many instances, finished parts of Ni-Span-C, "K" Monel, beryllium copper, 17-7PH and similar alloys are precipitation heat-treated in vacuum in order to provide protection from nitrogen absorption by titanium, aluminum, etc., to prevent discoloration and to eliminate costly finishing operations. Actually, almost the entire group of new super alloys, as well as some of the titanium alloys, are good candidates for precipitation hardening in vacuum. At least one aircraft company has already installed vacuum equipment for furnace brazing of fabricated parts to take advantage of clean surfaces and better brazing alloy fluidity. More activity can certainly be anticipated in this field.

Shop Aspects:
(How are these alloys vacuum heat treated?)

Except for differences in time and temperature, almost all materials are vacuum heat treated in the same manner. A prime requisite is to have clean surfaces in order to take advantage of the protection offered by vacuum. With proper solvent degreasing, it is common for titanium and zirconium to come out of the furnace

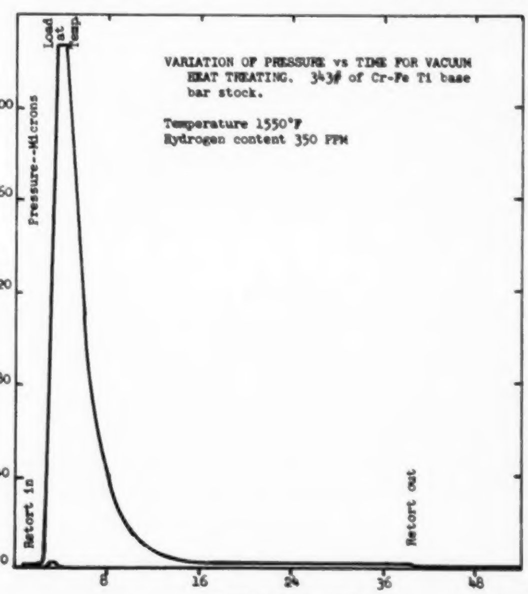

Fig. 1—Variation of Pressure vs. Time for Vacuum Heat Treating. 343 lbs. of Cr-Fe-Ti base bar stock.

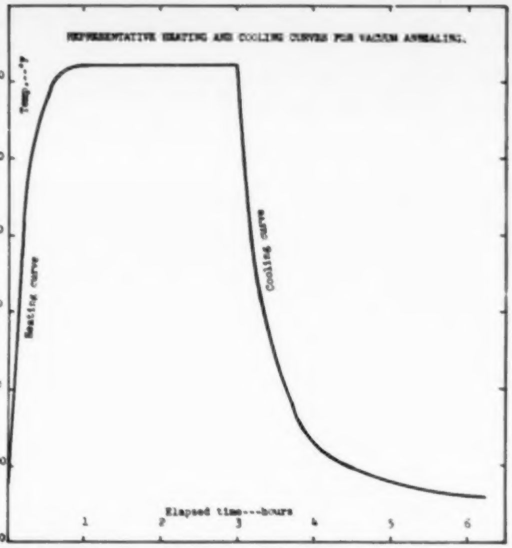

Fig. 2—Representative Heating and Cooling Curves for Vacuum Annealing.

brighter than they go in. All solvents and water must be removed since, if heated under vacuum, these will evaporate and contaminate the work load as well as affect diffusion pump oil and pumping rate.

From the operator's standpoint, the necessary equipment itself comprises one or more vacuum pumps and by-pass valves in addition to the furnace retort itself, and naturally, a heat treating furnace. As a supplement, vacuum gauges of several types are used to measure the pressure within the furnace retort as well as at other parts of the vacuum system. For the reactive metals, such systems will generally contain a mechanical vacuum pump in addition to a vapor diffusion or booster pump. The operation of these components is far less complex than those utilizing conventional protective atmospheres such as partially dissociated city gas or ammonia. There are no problems with CO:CO_2 ratio, hydrogen, methane or dew point. In practice, the furnace retort is closed off and evacuated prior to heating the work load. All of the pumps remain in operation until the heat treatment is completed, at which time the vacuum furnace retort is isolated and the pressure released to air after the work has cooled to a safe temperature.

Because vacuum heat treating is today a batch operation, it has frequently been difficult to estimate the total furnace time on a particular requirement. Actually, when temperatures above 1000°F are used, heating is by radiation, and in most cases is every bit as rapid as in conventional furnaces. The difficulty comes in the cooling time since, in a vacuum, most materials cool rapidly down to a black heat and then very slowly. In practice, cooling times can frequently be reduced by one-third by inserting helium or argon to reach a pressure of one millimeter during the cooling cycle. The greatest drawback comes in heat treating the reactive metals. Since these may have gases entrapped either on the surface or in the middle, they may require a longer time to reach a low pressure. A number of these problems can be remedied now that we have industrial experience with vacuum heat treating. For example, three years ago, one source quoted a 96-hour cycle to vacuum anneal a 300-pound coil of Zircaloy-2 strip, when we thought this should be accomplished in perhaps eight hours. Today, there are vacuum furnaces capable of annealing four thousand pounds of zirconium or titanium in eight hours.

From the operator's standpoint, all the reactive metals, as well as the more common metals, will be consistently bright annealed when using sufficiently low vacuum. This is a big difference from the problems of decarburization, carburization, sub-surface oxidation, nitriding and similar effects which result frequently with prepared atmospheres unless they are closely controlled.

Engineering Aspects: (What happens when metals are vacuum heat treated?)

In comparing vacuum with prepared atmosphere heat treatment, entirely new concepts are involved. The effect of prepared atmospheres depends upon chemistry, while vacuum technology depends upon physics. To make a rough comparison, we now substitute vapor pressures of metals for carbon potential of prepared atmospheres; we substitute dissociation pressures of compounds for chemical reactions between elements in gaseous compounds. These concepts are no more difficult than the chemical reactions of prepared atmospheres, but they are, perhaps, less familiar.

An example of the effect of vapor pressure is that water boils at a lower temperature at high altitudes than at sea level. The vapor pressure of the water is the same at high altitudes as at low ones, but the opposing pressure of the atmosphere is lessened, and thus the vapor pressure of the water matches that of the atmosphere at a lower temperature. In a similar way, the vapor pressures of metals are fixed and definite values

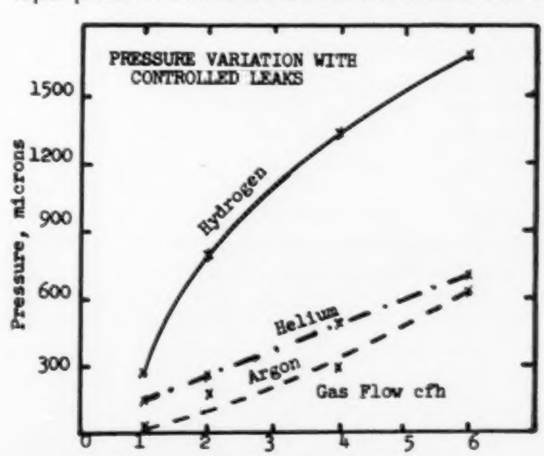

Fig. 3—Pressure Variation with Controlled Leaks.

at a given temperature, but if we remove the pressure of the opposing atmosphere, the metals evaporate more rapidly as shown in Table I. Some metals like magnesium have extremely high vapor pressures and would be expected to evaporate quickly during vacuum heat treatment. An examination of the vapor pressure of zinc indicates that vacuum annealing of a 70%-30% brass would result in dezincification. Thus a knowledge of vapor pressure data is of first importance in the vacuum heat treatment of metals. The calculated maximum vapor pressure of Type-304 stainless steel at 1500°F is shown below:

Element	*Weight Percent**	*Maximum Vapor Pressure MM*	*Microns*
Manganese	1.33%	.001 x 10^{-4}	.01
Silicon	.46	.00637 x 10^{-4}	.06
Copper	.25	.00023 x 10^{-4}	.002
Chromium	19.12	.0756 x 10^{-4}	.75
Nickel	9.62	.0008 x 10^{-4}	.008
Iron	69.11	.0007 x 10^{-4}	.007
Carbon	.07	.006 x 10^{-29}	nil

* Heat X46523

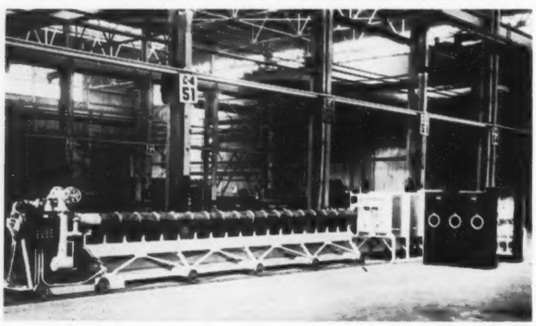

Fig. 4—Superior Tube Company 24-foot Vacuum Furnace.

According to this data, chromium would theoretically have a vapor pressure of 7.5 microns at 1500°F, and hence should evaporate rapidly in a vacuum of 1 micron. In practice, chromium does not rapidly evaporate from stainless steel since the chromium present on the surface is combined with oxygen to form chromium oxide, a compound.

The concept of dissociation pressure is also of great importance. Just as the elements have definite vapor pressures, compounds will have definite dissociation pressures. Thus, if the pressure in an evacuated vessel is less than the dissociation pressure of the compound, the compound will break down into its components and given enough time, will be completely dissociated. If the pressure in the vessel is higher than the dissociation pressure of the compound, vacuum heat treatment will have virtually no effect. In practice, stainless steel can be bright annealed in a vacuum of 10 microns or less, which provides adequate protection since the dissociation pressure of the chromium oxide normally on the surface of stainless steel is on the order of 1 x 10^{-24} microns. In contrast, the dissociation pressures of titanium hydride and zirconium hydride are extremely high so that these compounds can be dissociated readily. By vacuum heat treatment, we may thus prevent the formation of unwanted compounds, which utilizes the protective feature of the vacuum, where we may dissociate compounds which have already been formed in the metal, which utilizes the degassing feature of the vacuum.

Based upon the preceding evidence, one can now examine what takes place during vacuum heat treating. Figure 1 shows the amount of outgassing which occurred on a particular load of titanium alloy. While this type of curve is typical of an outgassing treatment where hydrogen is removed, the pressure rise on a subsequent anneal on the same material would not exceed perhaps five or ten microns. In this case, it can be seen from the data shown in Table 1 that the mechanical properties have been restored following the degassing treatment typified by the above figure. Subsequent work with stress rupture tests as well as with hydrogen analyses, indicates that hydrogen removal is essentially completed when the furnace pressure returns to the five micron level. In cases where improper cleaning or where moisture or solvent was left on the work load, the duration of outgassing might be increased by as much as 40 additional hours. Representative heating and cooling curves for vacuum annealing are shown in Figure 2.

TABLE I

EFFECTS OF VACUUM ANNEALING ON MECHANICAL PROPERTIES OF CR-FE TITANIUM BASE ALLOYS

	Tensile Strength	*Yield Strength*	*Elongation*	*Reduction In Area*
Initial	145,000 psi	135,500 psi	7.5%	5.16%
	105,000 "	98,000 "	9.0%	33.85%
	118,400 "	108,800 "	11.3%	23.6 %
Vacuum Annealed ..	147,500 "	135,500 "	35.6%	43.4 %
	135,000 "	127,000 "	33.4%	49.6 %
	135,500 "	131,500 "	42.3%	50.7 %
Required ..	130,000 "	120,000 "	15.0%	30.0 %

Pitfalls: (What precautions should be followed in selecting equipment?)

In most instances, vacuum heat treating equipment will consist of five elements:

(1) A suitable batch-type furnace.

(2) A vacuum retort or container.

(3) A mechanical pump to create a rough vacuum (20 microns).

(4) A vapor diffusion pump to create a good vacuum (down to as low as .01 micron).

(5) A mechanical holding pump to permit the use of by-pass valves on the vapor diffusion pump.

Actual details of construction will vary widely, but there are several features which should be given careful consideration. For example, the pressure of the atmosphere may seem scarcely significant in ordinary design work, but this pressure of 14.7 psi constitutes a surprisingly large load on a vessel which may have a yield

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AUTOMATIC FIXTURES FOR INDUCTION HEATING

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INDUCTION HEATING is outstandingly suited to repetitive jobs. Once the correct conditions are established, part after part can be processed with no variation of results. This is what makes possible the use of unattended, automatic fixtures for certain induction heating applications. This article will discuss some of the possibilities and limitations of automatic fixtures for induction heating, and will describe some outstanding examples of where automatic induction heating fixtures have been successfully applied.

The conditions which must be established and maintained constantly in order that an induction heating process continue repetitively with no inconsistency of results can be divided into two categories; those which can be controlled by the machine, and those which cannot. The first category includes such factors as:

Frequency
Power
Heating time
Shape of inductor
Electrical matching of inductor
Relative position of workpiece and inductor
Scanning rate, if progressive
Quench medium, pressure, and temperature
Quench time

The second category of conditions which, unfortunately in some cases, must also be held constant if the results are to be consistent, are:

Material of the workpiece
Physical dimensions of the workpiece
Initial temperature of the workpiece
Prior heat treatment of workpiece (if application is hardening)

It must be emphasized that the success of automatic fixturing for induction heating applications depends upon more than simply the ingenuity of the fixture designer. It is actually a cooperative enterprise between the manufacturer of the workpieces and the builder of the induction equipment. In planning a successful installation, it is imperative that there be a 100% meeting of the minds between the customer and the equipment manufacturer in order that a multitude of seemingly insignificant details can be ironed out in advance. It has been our experience that any investment of time, phone calls, or travel expense made during the early stages of the planning of an automatic induction heating installation pays handsome dividends in terms of time saved when the equipment is being installed, and in terms of preventing delays in getting into full, profitable production.

When should an induction heating application be made automatic?

Of course, there are savings which are immediately apparent, especially in terms of the manpower required

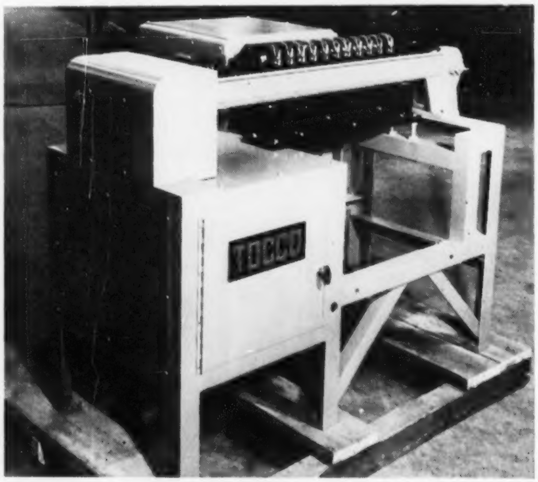

Fig. 1—Heating connecting rods for shrink fitting operation.

for operating. However, against this must be balanced any additional costs of ensuring that the variables over which the fixture itself has no control are taken care of prior to the delivery of the workpieces to the induction equipment. If it is physically impossible, or if the cost of delivering consistent parts to the induction heating machine is prohibitive, then it will probably be unwise to attempt to make it automatic. Cost of maintenance is another factor to consider, as is the cost of machine "down" time. If, by using an automatic machine, it is possible to eliminate one operator, but at

the expense of hiring two maintenance men, there is little gained.

Flexibility must also be taken into account. Usually, the higher the degree of automation, the closer is the approach to a single purpose machine. For example, it is readily feasible to design and build manually-loaded equipment for induction hardening the bearing surfaces on both crankshafts and camshafts, with a minimum of changeover setup time. But an automatic fixture for hardening *either* camshafts or crankshafts would probably be more expensive than two machines —one for each. In general, however, when conditions are favorable, a manufacturer cannot afford not to automate.

The part which ingenuity plays in the success of job shop induction heating is indeed impressive. However, the job shop, with its manually-operated fixtures, has one outstanding advantage. There is a man present to police what happens. He can see to it that the workpieces are right side up. If some of the conditions change because of the equipment warming up over a period of time, he is present to make the necessary adjustment. If a workpiece comes through which is too big for the locator, he can lay it aside; at least he does not try to jam it into too small an opening with the full force of a hydraulic cylinder. In the case of automatic equipment, all of these possibilities must be anticipated so that the equipment can run without someone there, or, in the event of serious abnormalities, so that it will not damage itself.

The electrical conditions in the category of variables over which the induction equipment can exert control are usually taken care of by relatively standard devices. Voltage regulators, accurate timing devices, precise temperature controllers, and well-regulated variable speed drives are all available as required.

Generally, the fixture itself has to do more with the mechanical aspects of the problem. Its primary purpose is to hold the workpiece in proper position relative to the heating coil or inductor. Automatic fixtures usually have the additional function of loading the work into that position and of unloading it with as little loss of valuable machine time as possible. Holding the workpiece relative to the inductor may also involve relative motion, either for scanning or for rotating, to improve uniformity of heating. The allowable dimensional tolerances of work position vary widely from one induction heating application to another.

An example of where extreme accuracy was not necessary is shown in Fig. 1. This fixture is for heating the wrist pin end of automotive connecting rods to a relatively low temperature for shrink fitting. The parts are carried on a simple chain conveyor through a loose-coupled channel coil.

Fig. 2 is an example of where accuracy near the other end of the scale was required. The application is to harden six automobile rear axleshafts simultaneously. The photograph does not show the workpieces in position. The flanges of the axleshafts are held in cup-shaped locators which are on the carriage below the opening on the front of the machine and also do not appear in this photograph. The spline ends of the shafts are held by the centers which are seen protruding through the one-turn, integral quench inductors. The vees behind the centers are to assist in loading. The flanged ends are first placed in the cups at the lower end of the machine, then the other ends are swung into approximate position, with their sides resting against the vees. The centers then come down, engage the upper ends of the shafts, holding them accurately, and the vees retract to permit vertical motion of the shafts. Note that the two right hand upper centers and vees are different from the other four. This is to permit the hardening of a considerably different shaft at these two positions, simultaneously with the hardening of two part numbers whose lengths differ from each other by about two inches in the other four positions. These two parts are loaded at random; there may be three long shafts and one short shaft in that group of four at the same time. This explains the seemingly excessive length of the machine centers. With short shafts, the heat and quench are simply continued progressively beyond the end of the shaft until the longer shaft has been completely hardened. There are two power supplies for this machine,—one for the two radically different shafts done in the right hand positions, and another for the group of four. After the upper centers have engaged the spline end of the six shafts, the carriage moves rapidly upward, and stops

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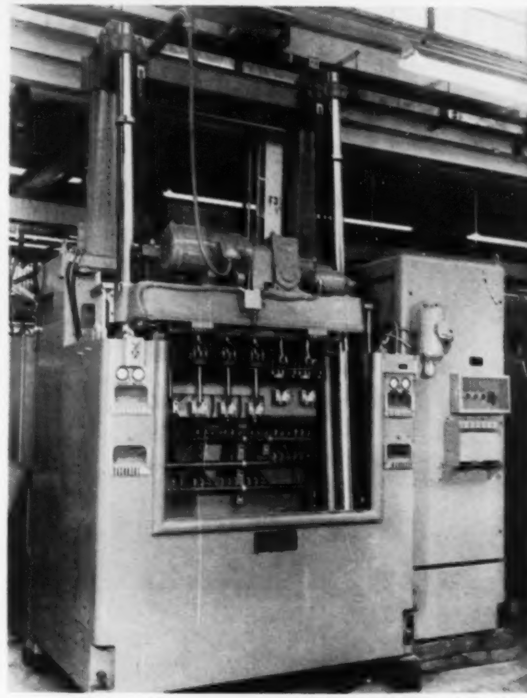


Fig. 2—Machine for hardening automobile axle-shafts.

HEAT TREATING "K" MONEL SHEET

By THOMAS A. DICKINSON
West Coast Reporter

MINIMUM Rockwell hardnesses of "C" 24 and "A" 62 are being maintained with unprecedented consistency in "K" Monel by means of a heat treatment which was recently adopted by the Convair Division of General Dynamics Corporation, San Diego, Calif.

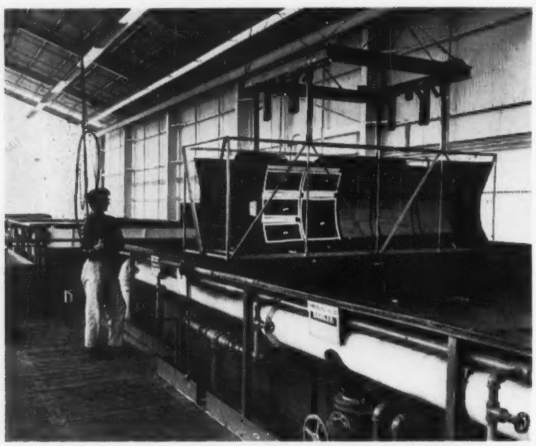


Fig. 1—Careful preliminary cleaning is generally necessary to avoid cracks in heat treating "K" Monel sheet.

"K" Monel is a non-magnetic alloy of nickel, copper, and aluminum. It is being used fairly extensively in many modern industries because it has excellent resistance to the corrosive action of most acids, alkalies, and brine. In addition, it can have mechanical properties comparable to those of heat-treated alloy steels (as indicated by the above hardness data) if it is properly aged.

Fig. 2—Parts to be artificially aged are loaded on racks or special fixtures and conveyed into furnaces.

According to B. R. Swarts of Convair's manufacturing development and process specifications department, all "K" Monel material should be carefully cleaned before it is either solution treated or age hardened because contaminants like sulfur, grease, and traces of lead, silver, molybdenum, and bismuth can cause it to crack. However, local discolorations due to heliarc welding need not be removed where there is no other evidence of surface impurities.

Cleaning operations required by Convair include vapor degreasing or hand wiping with a clean cloth soaked in toluene solvent; pickling for about one hour at 150° to 160°F. in a solution containing 10 to 12% hydrochloric acid and 2 to 3 ounces per gallon of cupric chloride; and brightening for 5 to 10 minutes at room temperature in a solution containing 10 to 12% sulfuric acid and 14 to 16 ounces per gallon of sodium dichromate. Pickling and brightening involve the removal of scale—or, more specifically, all oxide deposit on the metal. If present, said deposits are removed prior to heat treatment. Following either pickling or brightening operations, the metal is rinsed in tap water for 2 to 5 minutes at room temperature.

Where solution treatment (sometimes called annealing) is necessary, "K" Monel is heated to 1600°F.

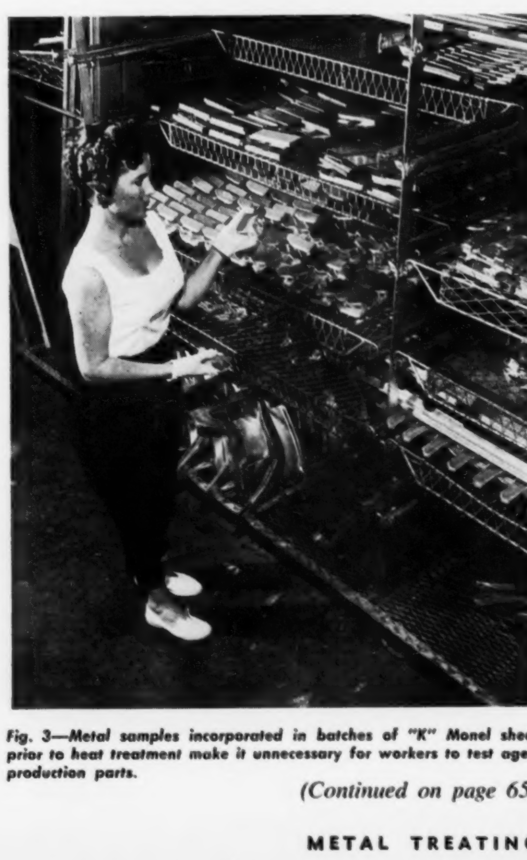
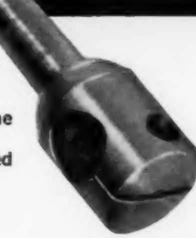


Fig. 3—Metal samples incorporated in batches of "K" Monel sheet prior to heat treatment make it unnecessary for workers to test aged production parts.

(Continued on page 65)



THE CASTING AND HEAT TREATING OF STEEL GEARS

By J. M. CALKINS, Metallurgist
and
VICTOR E. ZANG, Metallurgist

Unitcast Corporation
Toledo, Ohio

THE CHOICE of material and type of heat treatment to be used in the processing of cast steel gears depends largely on two factors, the ultimate use of the gear and the allowable cost of the part.

In general, three different analyses are being used. For carburizing and case hardening, SAE 0022 or SAE 0030 is usually specified. For flame hardening after machining, SAE 0050 is very often the choice. If a full hardening and drawing treatment is desired, specifications very likely will call for SAE 0105 or 0120. If extreme hardness of the tooth face is of primary importance, the choice of SAE 0030 with a case hardening operation seems to be the best method of obtaining it. This choice will combine very fine machining properties with high surface hardness up to Rc. 65, and consequently very good wear resistance in the finished part.

The chart shown in Fig. 1 indicates maximum % chemical analysis ranges and minimum physical properties required in the newest SAE specifications for carbon and low alloy steel castings.

Size of the part in question will often dictate the choice of material to be used. Small gears, costing less to carburize, having less mass and surface area will often be cast in the carburizing grades, while gears with extensive areas to be hardened will more often be requested in grades suitable for flame or induction hardening. Again, if relatively high working hardness coupled with slightly more moderate cost is desired, then very often SAE 0050 is furnished and the heat treatment consists of normalizing in the foundry as in the case of SAE 0030, but with a flame or induction hardening operation after machining to obtain hardness up to about Rc. 60. This analysis lends itself very well to full hardening and drawing if the desired working hardness is not too high.

The selection of a mild alloy steel to meet SAE 0105 or 0120 specification is usually a wise one even though the cost of the material is slightly higher. The steels usually furnished to meet these specifications are of two general types; the manganese molybdenum and the nickel-chrome molybdenum grades. These two grades offer versatility in that they may be flame hardened or full quenched and drawn using water or preferably oil as the quenching medium. Due to the greater depth of hardness obtainable with the use of these low alloy steels, a double treatment may be used where the part is quenched and drawn to give a high yield point and then subsequently flame or induction hardened on the teeth for greater wearing qualities. When these grades are used, we may quench and draw the part to obtain yield points up to 100,000 psi and subsequently flame or induction hardened on the teeth to obtain about Rc. 55 maximum hardness.

The availability of a good modern heat treat source may often dictate the choice of material to be used. If a good modern installation is handy, then very good results can be obtained using SAE 0050 steel; however, if available heat treating facilities are somewhat obsolescent or even antiquated, then the selection of

Fig. 1—Minimum Physical Properties and Maximum Chemical Composition Required for Carbon and Low Alloy Steel Castings.

SPECIFICATION & HEAT TREATMENT			MECHANICAL PROPERTIES—MINIMUM					CHEMICAL COMPOSITION %—MAXIMUM								
Specification	Class	(#) Heat Treatment	Tensile Strength p.s.i.	Yield Point p.s.i.	Elong. in 2" %	Red. of Area %	Other Tests: Bend, Impact Hardness†	C	Mn	P	S	Si	Cu	Ni	Cr	Other Elements
SAE							BHN									
Automotive	0022	A or N or NT	—	—	—	—	—	.12-.22	.50-.90	.05	.06	.60	—	—	—	—
	0030	A or N or NT or QT	65,000	35,000	24	35	131	.30 (b)	.70 (b)	.05	.06	.60	.50 (c)	.50 (c)	.25 (c)	W .10
	0050	N or NT	85,000	45,000	16	24	170	.40-.50	.50-.90	.05	.06	.20-.60	—	—	—	—
	0050	QT	100,000	70,000	10	15	207	.40-.50	.50-.90	.05	.06	.20-.60	—	—	—	—
	080	A or N or NT or QT	80,000	40,000	18	30	183	—	—	.05	.06	—	—	—	—	—
	090	NT or NQT	90,000	60,000	20	40	187	—	—	.05	.06	—	—	—	—	—
	0105*	NQT	105,000	85,000	17	35	217	—	—	.05	.06	—	—	—	—	—
	0120*	NQT	120,000	100,000	14	30	248	—	—	.05	.06	—	—	—	—	—
	0150*	NQT	150,000	125,000	9	22	311	—	—	.05	.06	—	—	—	—	—
	0175*	NQT	175,000	145,000	6	12	363	—	—	.05	.06	—	—	—	—	—

EXPLANATION OF SYMBOLS

Heat Treatment: A—Full Annealed; N—Normalized; T—Tempered; Q—Liquid Quenched.

* *Hardenability requirements when specified.*

(b) For each reduction of .01%C below the maximum specified, an increase of .04%Mn above the maximum specified will be permitted to a maximum of 1.0%Mn.

(c) Total maximum content of undesirable elements is 1.0%. For each .10% below the specified maximum alloy content of 1.0%, an increase of .02% in the Cr plus Mo content and .06% in the Ni and Cu contents above the specified maximum will be permitted.

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58-A

HEAT TREATING OF STEEL GEARS

(Continued from page 12)

the low alloy grades would seem a much wiser choice as they respond more readily to quenching and drawing and will harden much more deeply as indicated on the Jominy hardenability charts. (Figs. 2 and 3.)

Foundries producing cast gears can be of a very special service to their customers if they are adequately informed as to the machining and hardening practices to be used as well as the end use or purpose of the gear. Hardening operations are greatly facilitated by close control in the foundry operation. This control can be effected principally in the following ways:

1. Close control of melting operations so that analysis of the parts will not vary much from heat to heat. This is improved by use of choice melting scrap and by initiating an incentive system for melters which offers added financial reimbursement for close chemical control.

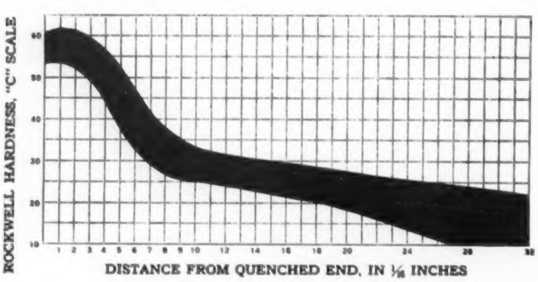


Fig. 2—Jominy Hardenability Curve SAE 0050 Steel.

2. Many foundries have adapted the practice of identifying castings to be subsequently hardened with a cast-on number indicating the heat in which they were cast. If this practice is coupled with the running of a Jominy hardenability bar on each heat in which the parts are cast, then any variations due to tramp residual alloys can be compensated for in the heat treatment of any given lot.

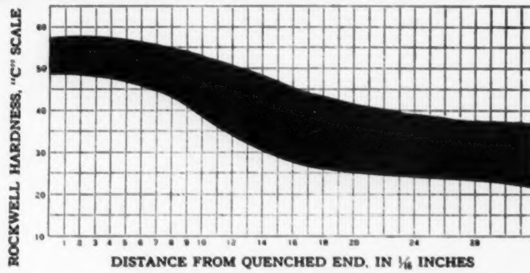


Fig. 3—Jominy Hardenability Curve SAE 0105 or 0120 Steels.

3. Close control of molding and pouring operations so that non-metallic inclusions necessitating repair welding can be held to a bare minimum.

4. Adequate control of heat treating operations both in the standard normalizing treatment as well as in any hardening operations which may be performed by the foundry. If care is taken in the normalizing cycle, minimum decarburization of the cast skin can be obtained, rendering future hardening operations more effective.

In general, close control can only be effected by mutual understanding between the foundry and the customer, an ideal situation which regrettably is often difficult to achieve. • • •

a problem in labor arbitration taken from the files of the American Arbitration Association

The Case of the Eliminated Job

When a contract was negotiated in a hosiery mill, management and the union agreed that employees could assert their seniority to claim jobs in other departments if their regular jobs were eliminated. Otherwise, when facing layoff for temporary lack of work, they could "bump" only within their own departments.

This definition of seniority rights seemed clear enough until the company decided that a certain operation, which had formerly been done by both men and women, was thenceforth to be performed by men only.

When the displaced women tried to bump into other departments, the personnel manager objected. "Your bumping rights are limited to your own department. Elimination of an operation is the only circumstance that would permit plant-wide bumping. That hasn't happened. You can have any job in your present department that your seniority entitles you to, but that's all."

"What do you mean, our jobs haven't been eliminated?" the women retorted. "As long as we can't go back to them they have been eliminated for us."

Eventually the case went to arbitration under the rules of the American Arbitration Association.

What Would YOU Do?

THE AWARD: The arbitrator upheld the grievance. He said: "Broad rights are unquestionably granted to displaced employees whose classifications have been discontinued because such employees lack any opportunity in the future to return to those jobs. By lodging the duties of certain female employees in male employees the company has effectively prevented displaced female workers from returning to their jobs."

The Case of the Discontinued Night Shift

Pay schedules in a bronze foundry included a ten percent differential for the night shift, with a further provision which guaranteed shift employees their premium rate whenever they were "temporarily transferred to aid and assist employees on the day shift."

When production schedules were curtailed in the spring of 1958, the night shift, consisting of nine men, was temporarily abolished. The men were transferred to day work and assured they would go back to their old schedules as soon as work picked up again. This actually happened a few months later.

But, meanwhile, these nine workers weren't getting their shift bonus and they thought they should. "This is a temporary transfer brought about at the initiative of the company," argued the shop steward. "The night men should retain their ten percent premium."

The company couldn't see it that way. "The contract requires us to pay the night shift rate only when we transfer a man for our convenience, not when we lay off a whole shift."

Eventually, the case went to arbitration under the Rules of the American Arbitration Association.

What Would YOU Do?

THE AWARD: The arbitrator called attention to the phrase: ". . . to aid and assist employees on the day shift." The temporary shut-down of a whole shift, he said, didn't fall into this category. There was no evidence that the transfer of men to the day shift was related in any way to a particular task that had to be done.

CAUTION: The awards in these cases are not an indication of how other arbitrators might rule in other apparently similar cases.

THE APPRENTICE CORNER

Editor's Note: This is the second article on this topic of a series which will be published in the next several issues. They have been abstracted from the book "Injury in Ground Surfaces" by Dr. L. P. Tarasov of the Norton Company Research Laboratories with the kind permission of the publisher, the Norton Company, Worcester, Mass., who also furnished the photographs.

Detection of Cracks in Hardened Steel

When cracks are present in a ground steel surface, they may be pronounced enough to be easily visible either directly or with an ordinary magnifying glass. Frequently, however, they are too fine to be distinguished so readily, or else they are covered over, at least partly, by flowed metal. Other methods are then required to reveal them with assurance.

The most satisfactory of these methods is magnetic particle inspection, in which the test piece is magnetized and a magnetic powder is deposited on the surface. Most of the particles then concentrate on the cracks, which are thus clearly outlined. The reason for this behavior is that cracks are tiny air gaps and the sides of the cracks act as the poles of magnets to which the magnetic particles are strongly attracted.

The well-known Magnaflux method is the commercial version of this procedure, and best results are generally obtained if their standard procedures are used. The particles can be dusted on as a dry powder or they can be deposited out of a kerosene suspension.

It is possible to obtain fairly good results even if Magnaflux equipment is not available, provided the piece can be magnetized properly. A strong electromagnet is useful in this connection. It is worth noting that the residual magnetism left in a piece of hardened steel after it is removed from a magnetic chuck is often all that is needed to make a magnetic powder adhere preferentially to cracks.

Not all Magnaflux indications are caused by cracks. When non-metallic inclusions are present in steel in sufficient size, they, being non-magnetic, act just like air gaps with respect to the magnetic particles. This means that the magnetic particles will concentrate on the surface directly above the inclusions.

Such behavior is especially noticeable with sulphurized free-machining steels, which purposely contain numerous non-metallic inclusions to improve the machinability. An example is shown in Figure 1. Here most of the Magnaflux indications in the round bar of carburized and hardened steel are due to surface cracks, but the very straight horizontal indications reveal the sub-surface inclusions. It is important to keep this in mind so as to avoid misinterpreting inclusions as cracks, which has been done occasionally.

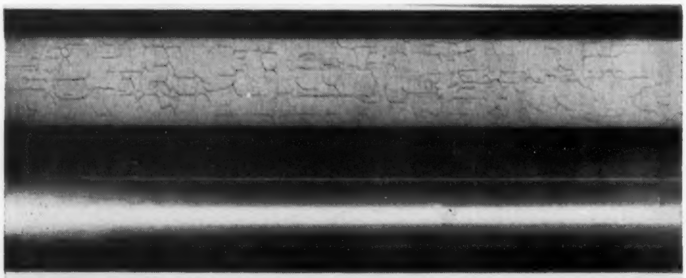


Fig. 1—Severely ground round bar of carburized and hardened steel, showing a Magnaflux pattern resulting in part from surface cracks and in part from non-magnetic inclusions purposely introduced into the steel to make it free-machining. The straight horizontal indications which cross the irregularly shaped ones correspond to inclusions near the surface and would be present even if there were no surface cracks. (Actual size)

Another way of bringing out cracks that are otherwise difficult or impossible to see is to etch the steel in nitric acid at room temperature. A short etch, of a few seconds' duration, will not widen the cracks appreciably, but when the surface is washed off in running water and wiped dry, the acid remaining in the cracks may seep out and discolor the surface at their borders, making it easy to detect the cracks. If the etch is prolonged sufficiently and the acid is strong enough, the sides of the cracks will be eaten away by the acid and the cracks will be wide enough to be directly visible.

The composition of the etchant and the duration of the etch will depend on the type of steel and the severity of the effect desired. Among the etchants that have been used successfully are five per cent nital, which is five per cent by volume of concentrated nitric acid dissolved in ethyl or methyl alcohol; two per cent concentrated nitric acid in water; or one part of concentrated nitric acid to two parts of water. The first two mainly discolor the surface without removing any appreciable thickness of metal, while the last etchant is a strong one, generally widening the cracks

(Continued on page 57)

M.T.I. *Activities*

QUARTER-CENTURY MILESTONE

In the history of any business institution or trade association there are many significant milestones which are passed, not the least of which is the reaching of the first twenty-five year mark.

In the life of a person, twenty-five years is usually regarded as the attainment of maturity, and a person's vitality and enthusiasm are at the peak. Fortunately, in the life of a trade association, these characteristics may not only come early but also continue to keep pace with the association's growth.

Such is the case of the Metal Treating Institute that has now reached its quarter-century status, and a brief summary of the highlights of the past years will substantiate its growth and progress.

The creation of the MTI resulted from the efforts of the U. S. government to draw up a Code of Fair Competition for the metal treating industry under the provisions of the National Industrial Recovery Act of 1933. The N.R.A. called an organizational meeting of leading commercial heat treaters to meet in Chicago in August, 1933, with C. U. Scott of C. U. Scott & Son, Rock Island, Illinois, presiding, and with 20 metal treating plants represented.

From the very beginning it was agreed that in order to present a code for an industry and to have an organized group to administer it, it would be necessary to create a permanent, incorporated national organization. Accordingly a set of bylaws was presented and agreed upon, officers elected and the date of the first Annual Meeting was set for October 3, 1933 in Detroit.

Prior to this meeting, the Institute was legally incorporated as a non-profit corporation of the State of Ohio at a meeting in Cleveland on September 1. Then on October 3, 1933 the first annual meeting of the members of MTI met in Detroit with 30 member companies in attendance.

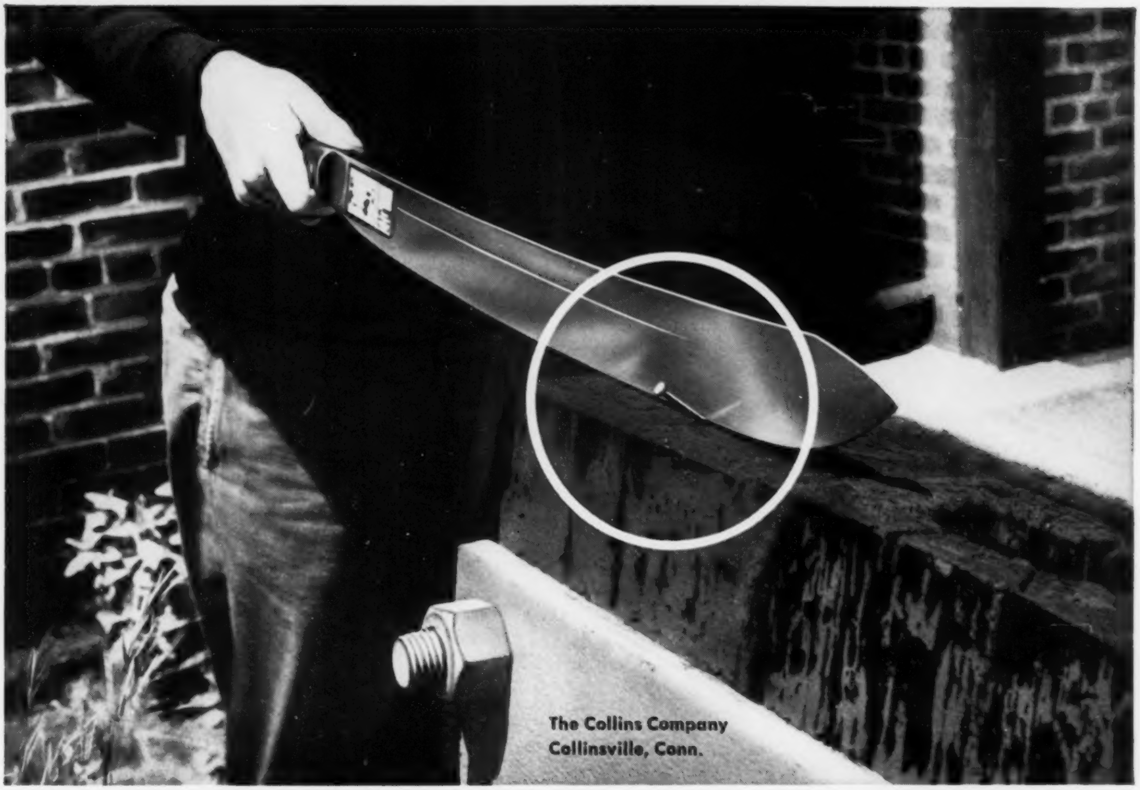
For the next few years the MTI met annually at different cities to elect officers and to report on the administration of the Metal Treating Industry Code Authority, but with the declaration of the unconstitutionality of the N.I.R.A., this activity ceased and membership fell off.

However, a strong nucleus of founding companies carried on; a "Barnstorming Tour" for members was made across the country in 1937, annual Spring Meetings were added to the Fall Meetings, and the Institute continued.

All during World War II the Institute continued to grow in members, in activities and in services to the industry. A national trade journal for the entire heat treating industry, "Metal Treating", was established, a headquarters office was opened with an Executive Secretary to administer the business of the Institute; and the membership continued to expand.

Today there are 81 member companies who, like their predecessors twenty-five years ago, are undertaking activities especially designed to assist their Institute, to

(Continued on page 46)



World's Sharpest Machetes are made with Cities Service Quenching Oil!

Hardened with Cities Service Quenching Oil, a Collins Machete can cut an eight penny nail in half—without damage to blade!

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"This oil has the perfect combination of characteristics for our operation," reports Collins. "It is a heavy oil, with high flash and fire point . . . and it's exceptionally oxidation-resistant. We're never troubled with sludge and we're able to maintain complete control over cooling temperatures."

Whatever kind of product *you* manufacture, if you want to make it the best in its field you need to use lubricants a cut above the rest. And like the Collins Company, you'll find they bear the label of Cities Service. Talk with a Cities Service lubrication engineer from the nearest office. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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ABSTRACTS

CYLINDER SLEEVES HARDENED WITH NEGLIGIBLE DISTORTION

When distortion during heat treatment is so pronounced that extensive machining operations are required to correct it, costs suffer. The necessity of reducing the distortion of their cast iron cylinder sleeves during heat treatment prompted Sealed Power Corporation, Muskegon, Michigan to adopt salt bath processing several years ago. At that time they installed mechanized austenitizing and draw furnaces at their Rochester, Indiana plant. Since then they have been operating on heavy production schedules.

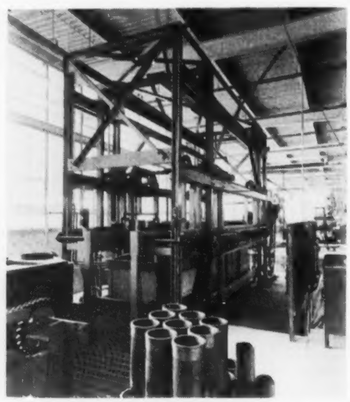
Maintenance costs over that period of time have been extremely low—the ceramic pot of the austenitizing furnace, has not required renewal in six years, and direct labor costs have been cut to half.

Cylinder sleeves manufactured by Sealed Power vary in size from 3-7/16 inch bore by 7½ inches long, to 7 inch bore by 16½ inches long. The weights vary from 4½ pounds to 32 pounds each.

Originally, a box-type, gas-fired furnace was employed for sleeve hardening. This arrangement was undesirable not only because of the distortion, decarburization, cracks, and soft spots, but also because of limited production. It required between 2½ and 3 hours to heat treat a cylinder sleeve.

After carefully investigating various methods of hardening cast iron sleeves, Ajax electric salt bath furnaces were installed at the Rochester plant. The hardening line contains a mechanized austenitizing furnace, oil quench bath, and separately mechanized hot water wash tank, tempering furnace, and second hot water tank.

The 140 kw austenitizing furnace, having bath working dimensions 54 inches long, 22 inches wide, and 23 inches salt depth, is equipped with a completely automatic mechanism for transferring the sleeves from the loading position through the furnace and back



Mechanized wash tank, draw furnace, and final wash tank which require 189 square feet of floor space. Typical cast iron cylinder sleeves in foreground. Edge of oil quench tank at left.

to the starting position for unloading. Basic operating principle of the mechanism is that the work immersed in the molten salt rides on fixtures supported by chain conveyors mounted over the furnace. When the immersion period is completed, cylinders are picked up by a return conveyor which transports

Operator at load—unload end of Ajax mechanized austenitizing furnace. The mechanism occupies but 80 square feet of floor space. Edge of oil quench tank at right.

them up and back over the bath to the starting point. Cylinders are then quenched over a plug in an oil quench tank that lies between the two mechanized lines.

A second similar mechanized arrangement is used to transfer work that has been quenched through a wash tank, draw furnace, and final wash tank. The draw furnace has working dimensions 120 inches long, 28 inches wide and 22 inches salt depth, and has a connected load of 100kw. Sleeves are automatically transferred (2 sleeves per fixture) through the three baths (wash, draw, and wash) by means of up-and-down, quick transfer conveyors. Completed cylinders are picked up by another conveyor and returned over the unit to the starting point.

Production with the Ajax mechanized units has doubled as compared to the original box-type, gas-fired furnace. Sleeves are now hardened with the following cycle: austenitize for 15 minutes at 1550°F, oil quench, wash, draw for 1 hour at 350°F-900°F, and a final wash. Draw temperatures are variable depending upon the final hardness requirements. Inside diameters of the sleeves are then bored and honed, and outside diameters are ground.

Mr. D. A. Paull, Chief Metallurgist, states, "These furnaces have been highly successful in minimizing distortion, and we feel that the sleeves currently being produced are superior metallurgically to the ones made using previous equipment. The furnace equipment has functioned very well, and we have run the austenitizing furnace six years without replacing the ceramic pot."

Source—TIPS AND TRENDS, published by Ajax Electric Co., Phila., Pa.

(*Continued on page* 44)

HOW KEY FORGING JET TURBINE TIGHT TEMPERATURE

ELECTRIC FORGING FURNACES at Thompson Products, Inc. (Harrisburg plant), both General Electric and Hevi-Duty units, are equipped with GLOBAR heating elements to assure precise temperature control of alloys used for compressor and turbine vanes and blades. Shown above is one of several aisles in which both furnaces and forging presses are located.

NEWS TO HEAT TREATERS...

QUICK-QUENCH FURNACE FOR ALUMINUM

A quick-quench furnace recently installed by Southern California Aluminum Treating Co., Los Angeles, can be used to solution heat treat, anneal, or age aluminum work loads weighing up to 6000 lbs. each.

Made by Lindberg Engineering Co., Chicago, it is one of the few furnaces in the plant that does not use natural gas—the least expensive source of heat in the Los Angeles area.

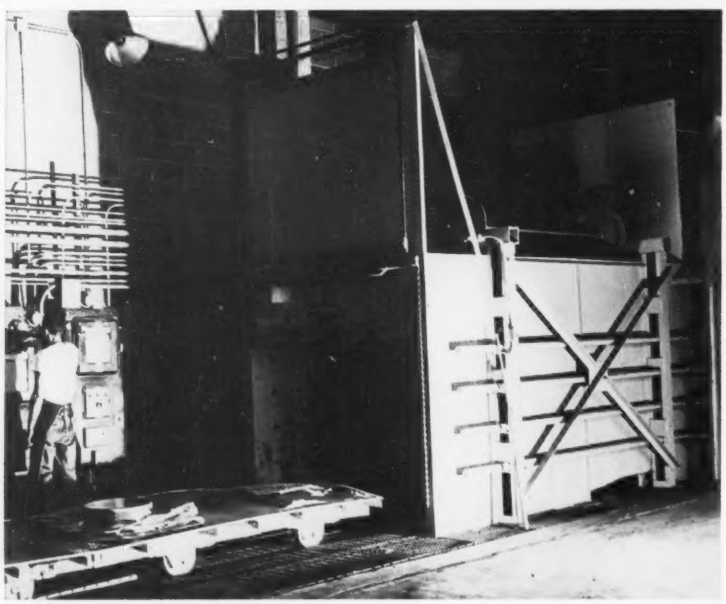
SCAT officials say they selected this unit (which is heated with 440-volt, three-phase, 60-cycle, 175-kw. power) in order to assure the control of temperatures with maximal precision below 1200° F.

Also important is the furnace's quick-quench feature, which permits use of water spray nozzles in minimizing distortion.

Loads are conveyed in and out of the heating and quenching compartments on rail-mounted cars. (See photo.)

When heating is done, high static pressures (up to 10,000 c.f.m.) are obtainable with a pair of blowers; and two-zone temperature control is maintained with Leeds & Northrup Micromax strip chart instrumentation (rated at 200° to 1200° F. with I. C. couples), DAT accessories, and Minneapolis-Honeywell Protecto Vane overheat facilities.

For further information circle No. 1



NEW SALES MANAGER

A. T. Ridinger, President of Metallurgical, Inc., Mpls., has announced the appointment of Gordon Moline, Kansas City, as national sales manager of the company.

Moline, who was assistant engineer of Metallurgical's Kansas City, Mo. plant has been with the company for four years. Prior to that, he was Supervisor of Metallographic & Physical Testing for the Buick-Oldsmobile-Pontiac Division of General Motors. He is a metallurgical engineer and a graduate of Missouri School of Mines at Rolla, Mo. He plans to move his family, Mrs. Moline and two sons to Minneapolis.

NEW "METAL SHOW" MANAGER

Appointment of Chester L. Wells as manager of the American Society for Metals' metal expositions ("Metal Shows") has been announced by the Board of Trustees of the Society.

Elevation of Wells from the post of assistant director of the Metal Shows was announced by ASM President G. MacDonald Young, technical director of the Aluminum Co. of Canada, Montreal.

Wells succeeds the late William H. Eisenman as head of the giant National Metal Show, held annually. Eisenman, who had been both national secretary of the Society, and managing director of the Metal Shows for 40 years, died on Memorial Day. The 40th National Metal Exposition and Congress will be held in Cleveland Oct. 27-31.

TITANIUM SYMPOSIUM

Engineers from government agencies and the titanium and steel industries met on the University Heights (Bronx) campus of New York University on September 8 and 9 for a conference on the alloying, processing, and heat treatment of titanium. The conference was presented by the metallurgical engineering department of NYU's College of Engineering and the University's Office of Special Services to Business and Industry. It was sponsored by six industrial firms—the Crucible Steel Company of America, the Electro Metallurgical Company, the Harvey Aluminum Company, the Mallory-Sharon Metals Company, the Republic Steel Corporation, and the Titanium Metals Corporation of America.

INDUSTRIAL FURNACE SALES

June net new orders for industrial furnaces totaled $3,672,000, up substantially from the excessively low volume attained in May 1958 and considerably higher than

the first six months' average of $2,967,000. Total net new orders for the first half 1958 amounted to $17,802,000, as compared to $43,348,000 in 1957 and $67,453,000 in 1956.

HARDENING DEMONSTRATION AT METAL SHOW

As a feature of their exhibit at the National Metal Exposition, Cleveland, Ohio, October 27-31, 1958, The Sentry Company of Foxboro, Massachusetts offers "on the spot" demonstration hardening of sample high carbon high chrome or high speed steel tools brought to the show by visitors.

A Sentry Model Y furnace, similar to the unit in the photograph, will be in operation in Booth 936, demonstrating the ease of producing clean, quality hardening on the easily decarburized M-10 high speed steels.

Visitors to the show are invited to bring samples of their high carbon high chrome or high speed steel tools for demonstration hardening.

For further information circle No. 2

CRUCIBLE COMBINES TECHNICAL FUNCTIONS

All metals research, development and metallurgical activity will be combined in a new Technology Department at Crucible Steel Company of America, leading specialty steel maker it was announced recently.

Joel Hunter, president, commenting on the change, said, "The accelerating technical program at Crucible requires a realignment of our organization to better coordinate scientific progress with changing customer requirements and improved steelmaking practice. The new technical organization provides a framework for extensive further development of our progress in technology."

The Technology Department will be headed by Dr. M. J. Day, Vice President-Technology, formerly Vice President, Research and Development.

D. I. Dilworth, Jr., Director of Metallurgy, will assume broadened responsibilities in the new Department including direction and coordination of metallurgical policies, standards and procedures; quality control methods; technical customer service; trade specifications; manufacturing standards and raw material specifications.

Concurrently, the Company announced two other appointments in the Technology Department:

W. E. Gregg has been named Director of Technical Development and Dr. W. L. Finlay, Director of Research.

Mr. Gregg, previously Works Manager-Titanium Division, will coordinate new product and process activities throughout the Company and manage patent and license activities.

Dr. Finlay, former Manager-Midland Research Laboratory, will be responsible for steel, titanium and special alloys research.

For further information circle No. 3

EDDY CURRENT CRACK DETECTOR

A new eddy current instrument has recently been added to the group of testing systems available from Magnaflux Corporation, Chicago. This instrument locates and

determines the relative seriousness of defects in all conductive materials. It also quickly sorts mixed lots of ferrous and non-ferrous metals for differences in hardness, alloy, and heat treat condition and measures the thickness of certain conductive and non-conductive coatings on conductive bases.

For further information circle No. 4

TEMPERATURE INDICATING TECHNIQUES

Tempil° products will be exhibited in Booth #422 at the forthcoming Metal Show in Cleveland.

The salient feature of the exhibit will be the demonstration by trained personnel of the Tempilstik° technique for determining temperatures in a variety of applications.

New Tempilstik° temperature ratings of 305°, 320°, 330°, and 345°F which are now under development will be presented for the

first time. The available range of Tempil° Pellets has been expanded and new Tempil° Pellets for 2550°, 2600°, 2650°, and 2700°F will make their first appearance at the show. These were developed to meet the increasing demand for Tempil° temperature indication at the ever higher temperatures encountered in jet engine and rocket technology.

Visitors will be invited to register for the Tempil° "Basic Guide to Ferrous Metallurgy". The demand for this plastic laminated wall chart remains unabated since it has become a standard reference for engineers, metallurgists, etc.

Sample Tempil° Pellets for 325°F will be available to visitors to give them an opportunity to familiarize themselves with Tempil° temperature indicating techniques.

For further information circle No. 5

NEW SALES MANAGER

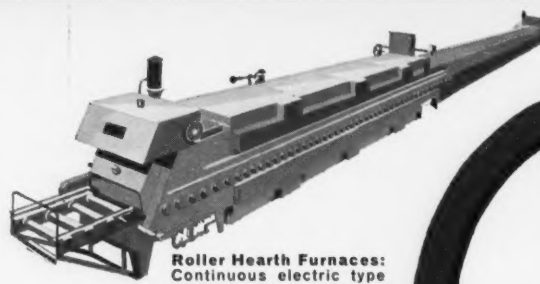
John E. King has been appointed the new sales manager of the J. W. Rex Company in Lansdale, Pa.

(Continued on page 31)

Wherever industry needs heat...

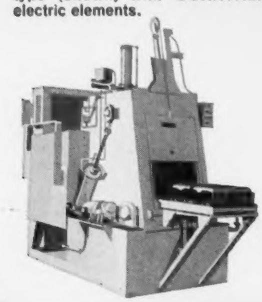
You'll find LINDBERG equipment just right for the specific job

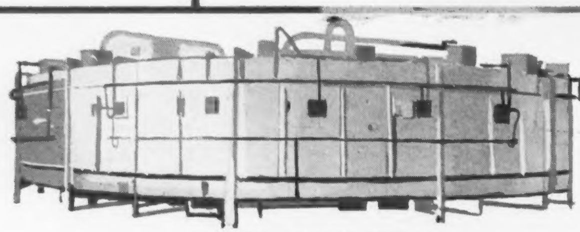
Pilot Plant Equipment: Atmosphere tube unit (shown) for processing work at temperatures to 2200° F.



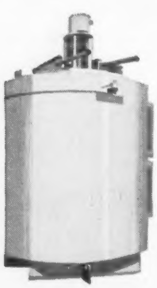
Roller Hearth Furnaces: Continuous electric type (shown) with temperature range 1300° to 2100° F.

Automatic Carbonitriding Furnaces: Automated integral quench type (shown) with CORRTHERM electric elements.

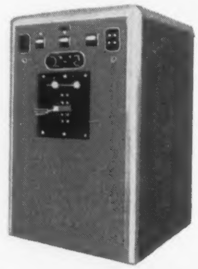




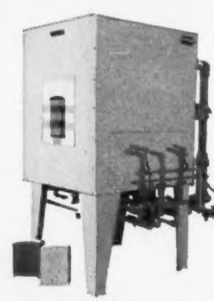
Rotary Hearth Furnaces: Doughnut type field-installed gas-fired furnace (shown) with capacity of 13,000 lbs. per hour.



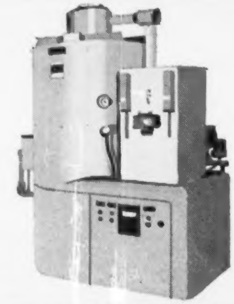
Vertical Type Furnaces: Carburizing and hardening furnace (shown) with CORRTHERM electrical heating elements.



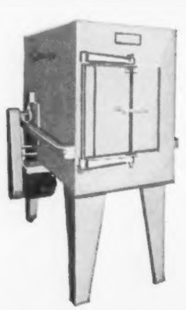
HF Induction Heating Units: Available in 5, 10, 25 and 50 KW units.



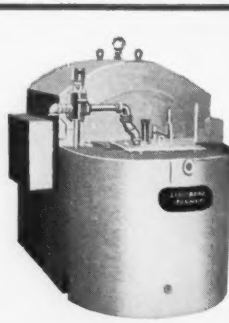
Ceramic Kilns: Gas-fired periodic kiln (shown) with temperature range to 3250° F.



Atmosphere Generators: Hyen generator (shown) for endothermic atmospheres. Generators for all required atmospheres.

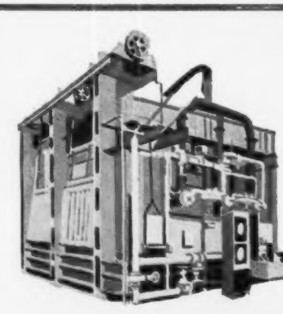


Tempering Furnaces: Box type Cyclone (shown). Temperature range to 1250° F.



Melting and Holding Furnaces: Electric resistance furnace (shown) with capacities of 750 lbs. to 1500 lbs.

Laboratory Equipment: One-unit box furnace (shown), muffle or for non-oxidizing atmosphere with temperature range to 3000° F.



Aluminum Reverberatory Furnaces: Twin-chamber melting and holding furnace (shown) with 45,000 lbs. capacity.

Lindberg-Designed

Unique Installation Cuts Heat Treating Costs and Improves Quality at Dayton

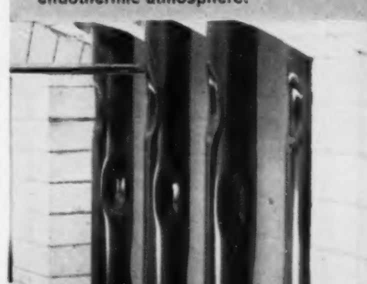
Here is a remarkable set-up for general heat treating now in operation at Dayton Forging & Heat Treating Company, Dayton, Ohio. Two integral quench atmosphere furnaces, largest of this type ever built by Lindberg, and one atmosphere tempering furnace in a "three-in-a-row" arrangement that simplifies transfer operation. Combined with Lindberg Carbotrol and Hyen generator, the entire furnace operation is completely automatic, including atmosphere control and recording. Planned by Dayton and Lindberg engineers, the installation runs around the clock, six days a week, reducing costs and producing cleaner end products, brighter job finish, freedom from "decarb" and a consistently higher quality of work.

This is another example of how Lindberg equipment and Lindberg planning can help you find the most effective answer to any problem of applying heat to industry. We cover the field, heat treating, melting and holding, tempering, brazing, enameling furnaces, ceramic kilns, high frequency units, and are in the ideal position to recommend just the type of equipment most suitable for your needs. This can be factory built or field-installed in your own plant, fuel-fired or electric, whatever is best suited to your production processes. Consult your local Lindberg Field Representative (see the classified phone book) or get in touch with us direct. Lindberg Engineering Company, 2466 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 S. Regentview Avenue, at Downey, California.

Charles Hewitt, President of Dayton, says, "The Lindberg installation has kept our production at a consistently high quality level."

Work loads are positioned manually, but entire furnace operation is fully automatic.

Lindberg Carbotrol unit automatically controls and records "dew point" and heating cycles of endothermic atmosphere.



Lindberg's "dimple" vertical radiant tubes give remarkably trouble-free service and function at all times at full efficiency.

LINDBERG heat for industry

HEAT TREATING HINTS

Nitriding In Salt Baths

Salt bath nitriding operations may be carried out in a variety of salt mixtures that contain a high percentage of cyanide. The mixture most generally used contains 55 to 65% sodium cyanide and 35 to 45% potassium cyanide. This or other modifications of composition are most effective after they have been cured by standing molten to permit the formation of at least 5% cyanate. The cyanate content should never be allowed to fall below 5% and may be kept at the proper level by bailing out and adding fresh salt mixture. Good practice requires that the bath occasionally be cooled to just above its melting point, and that the excess carbonate salts be removed by scooping the sludge from the bottom of the pot.

The main purpose of nitriding is to produce a near-resistant hard case on the ground surface of the tool. Even though the case depths are shallow (.00035 to .0015) it may cause some brittleness in tools of delicate shape, and case depths should be judged accordingly. The temperatures at which nitriding takes place varies from 950° F to 1050°F and the time at heat from 10 min. to 1½ hrs.

High speed steels comprise the greatest amount of tools that are salt bath nitrided after finish grinding since the addition of the hard case increases the cutting qualities of the tool. Drop forgings have also been nitrided and have shown excellent improvement in die life.* Boeing Aircraft Co. of Seattle has done extensive research in regard to salt bath nitriding of various types of stainless and 17-7PH steels. The case depths are approximately half of those formed during an equal exposure in gaseous nitriding, but the technique is generally simpler and less expensive.

***"Application of Nitriding to Hot Forging Dies" by Alexander F. Sherys, *Metal Treating*, Jan.-Feb., 1955 (Reprints available by writing *Metal Treating*, 271 North Ave., New Rochelle, N. Y.)**

Fred Heinzelman, Jr.
Fred Heinzelman & Sons

Heat Treating Titanium Pressure Vessels

By THOMAS A. DICKINSON
West Coast Reporter

Probably the first heat-treated titanium-alloy pressure vessels are now being produced by Titanium Fabricators, Inc., Burbank, Calif., for use in aircraft and missiles.

Such vessels are used to store gases like oxygen, helium, and carbon dioxide under pressure. They can and have been made from numerous materials—including paper fiber and stainless steels—for many conventional and unconventional industrial applications of the past. But no previously-produced lightweight vessels are known to have been capable of storing as much gas in as little space as the subject titanium products. Therefore, it is entirely possible that titanium pressure vessels will eventually find many uses outside of the aeronautical field.

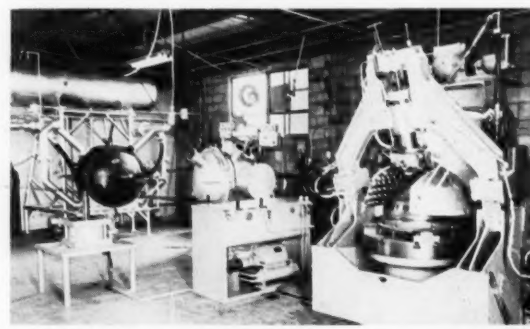


Fig. 1—General view of Titanium Fabricators' pressure vessel production facilities. Spinning lathe at right is used to form titanium hemispheres. Semi-automatic heliarc equipment within the chamber in center background does welding. Furnace at left heat treats welded components and uses water from overhead storage tank to quench them.

The new vessels are spherical containers made from 6A1-4V alpha-beta alloy, in which aluminum stabilizes the alpha phase and shifts the beta transus up to 1800° ±50° F. while vanadium serves as a mild beta stabilizer (which does not form a eutectoid decomposition product or cause compound embrittlement like chromium or iron).

In addition to pure titanium, this alloy may comprise 5.5 to 6.5% aluminum, 3.5 to 4.5% vanadium, 0.1% (maximum) carbon, 0.03% (maximum) nitrogen, 0.2% (maximum) oxygen, and 0.6% (maximum) other elements. Among the "other elements," hydrogen is most critical and is not allowed to exceed 0.0150% in the 0.185" to 0.325" thicknesses of plate stock used by Titanium Fabricators.

To convert the plate stock into components of spherical pressure vessels, it is initially necessary to prepare circular blanks for the spinning of hemispheres with 16", 22", and 25" diameters.

Prior to being formed, the blanks are usually preheated to about 800° F. in a special electric furnace which has an atmosphere of air in its 36"-diameter, 24"-deep work chamber.

Preheated blanks are subsequently converted into

(Continued on page 56)

NEWS TO HEAT TREATERS

(Continued from page 27)

King was previously associated with other Philadelphia concerns as metallurgist and sales engineer. His last connection was as assistant to the manager in Defense Products with the Heintz Division of Kelsey-Hayes Co. in Philadelphia, Pa.

BRINELL HARDNESS CONTEST

Equipment never before shown at the National Metal Show by Steel City Testing Machines, Inc., will be featured in Booth No. 442, along with a contest to see how accurately Brinell hardness can be guessed when only a file is available. One of the more interesting of the newer testing machines is a portable tensile tester. This machine can be used for testing flat or round specimens in the field. There are no location limitations because the unit includes an integral hydraulic pump and requires no outside power source.

In the contest—prize for which is a personal, transistorized portable radio—each contestant will guess the Brinell hardness of three specimens. Their only help will come from the "feeling" they get after using a file on each specimen.

The Penetrascope, a portable hardness tester, will also be shown. This tester can be used on awkwardly shaped parts of any size. Various models are held against the workpiece by chains, clamps or magnets.

For further information circle No. 6

PYROMETER COMPANY

Pyrometer Company of America, a new organization that will manufacture instruments, thermocouples and accessories, has just been formed in Penndel, Pennsylvania.

Operating in a new 12,000 square foot steel and masonry structure, the company plans to concentrate initially in the production of a complete line of standard pyrometric accessories of premium quality.

For further information circle No. 7

(Continued on page 38)

YOU CAN FIND BOTH THE BIGGEST AND THE BEST AT YOUR COMMERCIAL HEAT TREATER

A new gas fired Homocarb said to be the world's largest.

THE THREE FURNACES shown on this page are units of the facilities of three commercial heat treating plants in different sections of the country.

Today, with the ever growing demand for *better* heat treating, economical volume equipment of this sort is becoming essential and the commercial heat treater has been alert to industry's requirements.

Quality work and versatility are the keynotes of this industry's objectives when treating the thousands of vital, intricate, and costly components of important products.

Whatever your heat treating problem, and whether it involves pounds or tons, always consult your *commercial* plant first.

Write for the folder
"HEAT TREATERS CITE SHORT CUTS TO MORE EFFECTIVE PURCHASING."

Large capacity vertical furnace for heat treating large parts.

A Vacuum Heat Treating Furnace for special materials.

THERE'S A HEAT TREATING SPECIALIST NEAR YOUR PLANT

CALIFORNIA

Certified Steel Treating Co.
2454 E. 58th St., Los Angeles 58
Hollywood Heat Treating Co.
1041 N. Mansfield Ave., Los Angeles 38
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12
Ireland Heat Treating Co.
512 Boston Post Road, Orange

ILLINOIS

Senecca Heat Treating Co.
124 S. Batavia Ave., Batavia
Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Allied Metal Treating Corp. of Illinois
333 N. California Ave., Chicago 12
Dura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22
Pearson Steel Treating Co.
5757 W. Odgen Ave., Cicero 50
Perfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kinzie St.. Chicago 22
American Steel Treating Co.
P. O. Box 225, Crystal Lake
Eklund Metal Treating, Inc.
721 Beacon St., Loves Park, Rockford
Lindberg Steel Treating Co.
1975 N. Ruby St., Melrose Park
Ipsenlab of Rockford, Inc.
2125 Kishwaukee Street, Rockford
O. T. Muehlemeyer Heat Treating Co.
1531 Preston St., Rockford
C. U. Scott & Son, Inc.
1510 First Ave., Rock Island

INDIANA

Quality Steel Treating Company
1630 Locust Street, Anderson

MASSACHUSETTS

Kinetics Corporation
2 Churchill Road, Hingham
New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
Greenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Anderson Steel Treating Co.
1033 Mt. Elliot Ave., Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Standard Steel Treating Co.
3467 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Lincoln Heat Treat, Inc.
21235 John R, Hazel Park
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1727 Manchester Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Metal Treating Corp.
611 Grove St., Elizabeth 2
American Metal Treatment Co.
Spring and Lafayette Sts., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Owego Heat Treat, Inc.
Rural Route 1, Apalachin
Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E. Rochester 5
General Heat Treating Corporation
206 Sand Street, Syracuse 3
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 11
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Drever Company
Red Lion & Philmont Rds., Bethayres
Robert Wooler
Dresher
J. W. Rex Co.
834 West 3rd St., Lansdale
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
Gulph Road, King of Prussia
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 169, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Houston Heat Treating Company, Inc.
2100 Quitman Street, Houston 26
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

All of the above listed firms are members of the

METAL TREATING INSTITUTE

271 North Avenue, New Rochelle, N. Y.

MTI MASTER CRAFTSMEN METAL TREATING INSTITUTE

NEWS TO HEAT TREATERS
(Continued from page 31)

PITTSBURGH REPRESENTATIVE

Frederic O. Hess, president, Selas Corporation of America, Dresher, Pa., announces the appointment of Cecil L. Kerr as sales representative in the company's

Pittsburgh Sales District.

Mr. Kerr joins John L. Wilson who has been sales representative for the past 10 years. They will make their new headquarters at 345 Mt. Lebanon Blvd., Pittsburgh 34.

ASM APPOINTMENTS

Adolph O. Schaefer, President, Pencoyd Steel and Forge Corporation, Philadelphia, has accepted appointment by the Board of Trustees of the American Society for Metals to the unexpired term of secretary of the Society following the recent death of founder-member William H. Eisenman, who for forty years had served as national secretary.

In making this announcement, G. M. Young, president of the Society and technical director, Aluminum Company of Canada, Ltd., Montreal, said that "the Board was most fortunate in securing the services of Mr. Schaefer who is a busy executive, but a man who has always been devoted to the welfare and progress of ASM".

Young also announced that the Board had appointed a temporary manager of the Society, an advisory council, and had established a new position of secretary to the Board.

Ray T. Bayless, long-time assistant secretary of the Society, will continue in this position and will become, in addition, temporary manager to direct activities at the headquarters offices here. Five ASM staff members appointed to the advisory council were A. P. Ford, Evelyn G. Gardner, Taylor Lyman, Ernest E. Thum and Chester L. Wells.

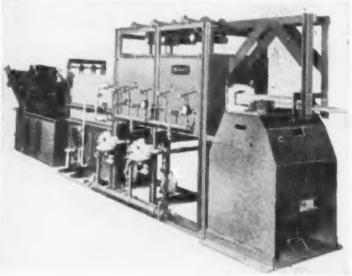
Miss Gardner was also selected for the newly-created position of secretary to the Board of Trustees. Many of the detailed matters pertaining to the office of secretary have for years been taken care of by Miss Gardner in her capacity as secretary to the late Mr. Eisenman. She has an extensive knowledge of all aspects of the Society's operations. She was also appointed secretary of the ASM Foundation for Education and Research.

Mr. Schaefer is a past president of the Society and has been active as a national trustee and in local affairs of the Philadelphia Chapter, having served as secretary, treasurer and chairman of the local group. A graduate of the University of Pennsylvania, he has been associated with many activities in the metal industry. He received the Delaware Valley Metals Man of the Year Award from the Philadelphia Chapter in 1954.

SHAKER HEARTH FURNACE

The American Gas Furnace Company, Elizabeth, N. J., has introduced a new line of Reciprocating Furnaces designed for the bright annealing and bright hardening of small stainless steel parts at temperatures up to 1900°F. The latest model No. 264 Reciprocating Furnace illustrated in the photograph has a capacity of approximately 100 pounds of stainless steel parts per hour.

The basic principle of operation consists of imparting a forward movement to the work conveying muffle and the work pieces resting in it. The forward movement is interrupted suddenly, causing the work pieces to advance by their own momentum.



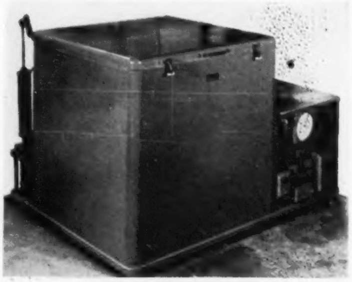
The furnace construction employs an alloy muffle which incorporates a purging, heating and water-jacketed cooling section, and seals into an automatic conveyorized oil tank.

This furnace will be exhibited at the Metal Show in Cleveland at Booth No. 2027.

For further information circle No. 8

LOW TEMPERATURE UNIT

A new industrial low temperature unit which can bring 350 pounds of AM-350 stainless steel per hour from plus 80° to minus 120°F. is now in production at Cincinnati Sub-Zero Products, Cincinnati, Ohio. The lid of the 64 cu. ft. chamber is opened and closed by an air lift device mounted on the rear of the chamber.



It is designed for "quick aging" of the newest stainless steels now in use in the aircraft and missiles field. Stability is achieved at a transformation temperature below that of room temperature.

For further information circle No. 9

(Continued on page 40)

WILSON "ROCKWELL"

HARDNESS TESTERS

WORLD'S STANDARD OF ACCURACY

ACCO for Better Values

EQUIPMENT for EVERY Hardness Testing Requirement

No matter what your hardness testing requirements are, there's a WILSON "ROCKWELL" instrument to do the job. Choose from this complete selection of hardness testers:

"ROCKWELL"—for most hardness testing functions.

Superficial—for extremely shallow indentations.

Twintester—combines functions of "ROCKWELL" and "ROCKWELL" Superficial testers.

Semi-Automatic (manual feed) and Fully Automatic—for automatically classifying tested pieces as CORRECT, TOO HARD, or TOO SOFT—at test rates up to 1000 pieces per hour.

Special Machines—for testing large objects, obtaining internal readings, and other unusual applications.

ALL WILSON "ROCKWELL" hardness testers provide these advantages:

Accurate performance—precision built, with exact calibration, for consistently correct results.

Long life—durable as a machine tool.

Easy operation—even an unskilled operator can get perfect readings. All controls conveniently grouped.

Easy maintenance—interchangeable mechanisms, with spindles mounted on oil-less bearings.

DIAMOND "BRALE" PENETRATORS

for perfect testing every time

A perfect diamond penetrator is essential to accurate hardness testing. Since one point of hardness on the "ROCKWELL" scale represents only 80 millionths of an inch of penetration—only 40 millionths on a Superficial tester—the slightest imperfection will cause a false reading.

Only *perfect* Wilson Diamond Brale Penetrators are sold. Each diamond is flawless, with no chips or cracks. It's cut to an exact shape. Microscopic inspection and a comparator check of every diamond—one at a time—assure this perfection—and assure you of accurate hardness testing every time.

A COMPLETE LIBRARY of Helpful Information

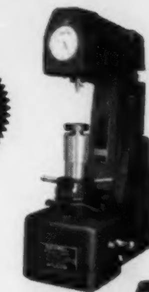
A wide variety of bulletins tells about hardness testing, and describes the many instruments, accessories, and services Wilson offers. Write for your choice:

DH-325—WILSON "ROCKWELL" Hardness Testers • **DH-326**—"ROCKWELL" Superficial Hardness Testers • **TT-58**—"ROCKWELL" Twintester • **DH-327**—Special "ROCKWELL" Testers, including Automatic and Semi-Automatic models • **DH-328**—TUKON Tester, for precision MICRO and MACRO testing

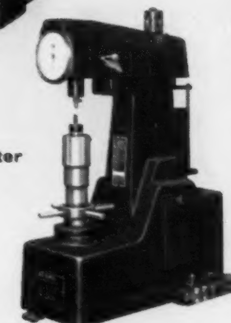
ACCO **WILSON**

MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE

230-R Park Avenue, New York 17, N. Y.

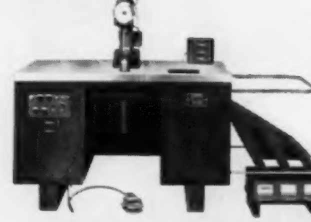


"ROCKWELL"

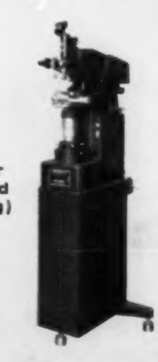


Twintester

Superficial



Automatic



TUKON Tester (for MICRO and MACRO testing)

NEWS TO HEAT TREATERS

(Continued from page 38)

NEW SULFONATE

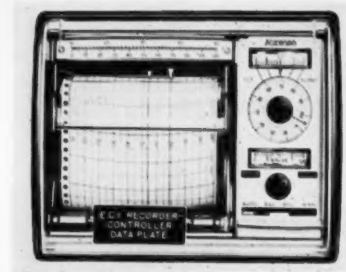
A new lighter-colored, oil-soluble sodium sulfonate is now available from Sun Oil Company's refinery at Marcus Hook, Pennsylvania. New sulfonate LC has a maximum ASTM (dilute) Color specification of 3½ and is available in tankcar and tank truck quantities.

The new sulfonate is recommended for compounding, emulsifying, dispersing, and wetting agents; rust and corrosion inhibitors; demulsifying agents; dry cleaning compounds; fat-splitting agents; flotation agents; fuel oil, grease, and lubricating oil additives; metalworking oils; textile oils; and pigment dispersing agents.

For further information circle No. 10

ELECTRONIC RECORDERS

Compact 1 and 2-pen Electronic Consotrol Recorders with full 4-inch strip charts have been announced by The Foxboro Company, Foxboro, Mass., as part of its



new line of electronic control instruments.

The new instruments are designed for economy of panel space. Slide-out chassis with stretch-out cord permits recording unit withdrawal without interruption of service. A powerful deflection motor operates directly from the transmitted 10-50 ma d-c measurement signal to drive the recorder pen.

For further information circle No. 11

UNIVERSAL ELECTRONIC RECORDER

The Hays Corporation, Michigan City, Indiana has introduced a new circular chart recorder to the instrumentation field.

With a maximum of four records possible on one circular chart, the new recorder has a number of unusual features. Unlike most strip chart potentiometer type recorders, the Hays Recorder utilizes a cam in all its electronic receiver units which can correct for non-linearity of input signals. This one feature permits the use of the Universal Electronic Recorder with as many as four non-linear inputs. Inputs such as flow, gas analysis, pH, pressure, etc., can be handled on a single equally divided chart.

For further information circle No. 12

(Continued on page 42)

NEWS TO HEAT TREATERS

(Continued from page 40)

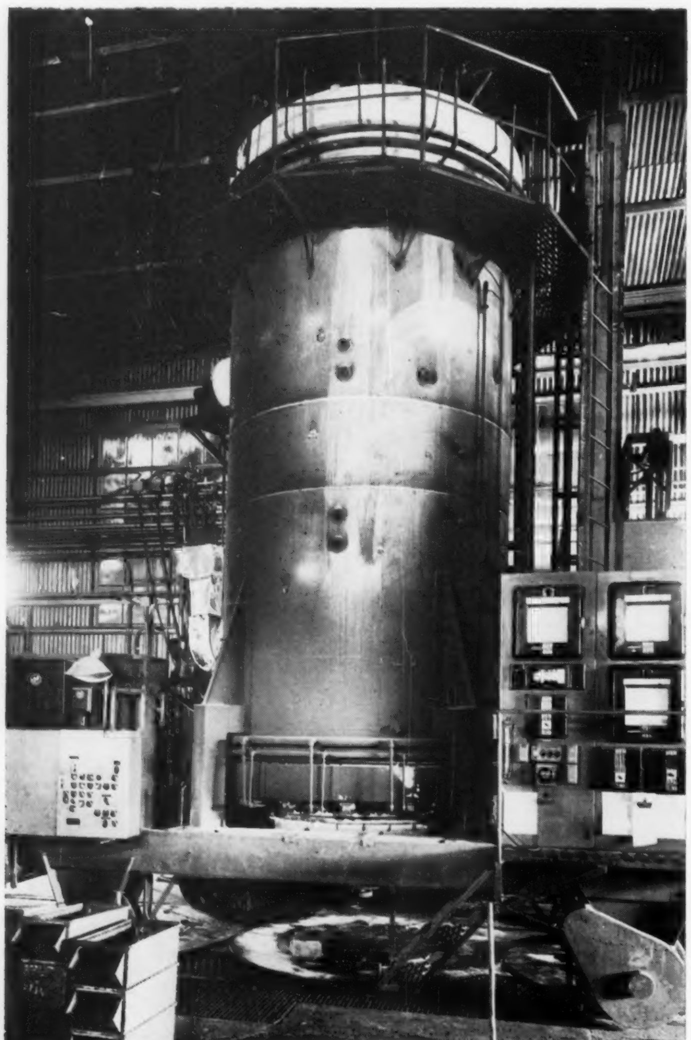
VERTICAL HEAT TREATING FURNACE

With the advent of new stainless steel alloys that take special heat treatment, industry had to come up with special furnaces and unusual cooling units for treating these steels. For instance, Allegheny Ludlum Steel Corporation's AM-350, a precipitation hardening stainless steel used primarily in the aircraft and missile industries, can be either heat or sub-zero treated to get special properties from the steel.

Pictured here is a special vertical heat treating furnace at the Cal-Doran Heat Treating Company, Los Angeles, California. Much of the material heat treated in this furnace must be subsequently treated at unusually cold temperatures. The furnace holds fabricated parts to 1900 degrees F. or better, to effect certain metallurgical changes to take place in the alloy.

In conjunction with the Cal-Doran furnace is a special cold treating unit capable of maintaining minus 108 degrees F. The Cal-Doran furnace can take parts up to 55 inches in diameter and 16 feet in length. The furnace is designed so that any atmosphere may be utilized, such as endothermic, exothermic, Argon, nitrogen, hydrogen and others. Special steels like AM-350 need special treatment so they can better perform today in jet aircraft and missiles. Fabricators report that extra care taken beforehand means better, stronger, longer lasting materials to withstand the high temperatures met in space travel.

For further information circle No. 13



NEW HIGH-TEMPERATURE ALLOY

An improved high-temperature alloy known as Carpenter Lapelloy "C" has been developed by The Carpenter Steel Company, Reading, Pa. for jet engine parts requiring excellent ductility and good impact resistance.

Carpenter Lapelloy "C", (U. S. Patent No. 2,816,830), has a more homogeneous structure and more uniform fabrication behavior and mechanical properties than the conventional Lapelloy. It is used for highly stressed parts involving service temperatures up to 1200°F. Lapelloy "C" has greater ductility and impact strength at both room and elevated temperatures than conventional Lapelloy when heat treated to the same strength level.

High mechanical properties *can be developed by heat treatment.* It has good resistance to scaling and oxidation for continuous service up to 1400°F. The alloy offers best corrosion resistance when in the hardened and tempered condition. It is used for compressor wheels, turbine shafts, compressor buckets, blades, and bolts.

Type analysis of Carpenter Lapelloy "C" is: Carbon, 0.20 - 0.25%; Manganese, 0.65 - 1.00%; Silicon, 0.50% max.; Chromium, 11.00 - 12.00%; Nickel, 0.50% max.; Molybdenum, 2.50 - 3.00%; Copper, 1.75 - 2.25%, and Nitrogen, 0.06 - 0.10%.

Lapelloy "C" is made by Carpenter's Mel-Trol process, a new quality control system with patented ingot design. Mel-Trol is used to minimize the causes of inconsistent centerline quality.

For further information circle No. 14

(Continued on page 50)

Incoloy annealing hood raised above coils of Monel* nickel-copper alloy strip, at Plume and Atwood plant, Thomaston, Conn. Hoods made by Rolock, Inc., Fairfield, Conn.

Still going strong after 5000 hours at 1200°-1450°F ...annealing hood of economical Incoloy

For 5000 hours, this Incoloy* nickel-iron-chromium alloy annealing hood has withstood 1200-1450°F service temperatures.

Notice there's no scaling or warping. No cracking either, even though it regularly goes through the severe thermal shock of spray quenching. It's as good as the day it left the fabricator's shop.

Plume and Atwood, producers of quality coiled strip of copper, brass, Monel and other alloys, have 8 of these Incoloy hoods. All are in excellent condition and in constant use.

You can expect this kind of service from other wrought Incoloy equipment such as retorts and thermocouple tubes. The reason... high strength and corrosion resistance at elevated temperatures.

With a growing reputation for economical performance in heat-treating applications up to 1800°F; with easy forming, and good welding properties; with relatively low initial cost; Incoloy equipment may well be just right for your operations.

For quotations on Incoloy equipment, ask your fabricator. For further information on these Incoloy alloy annealing hoods – ask Rolock, Inc., Fairfield, Conn. *Registered trademark

The International Nickel Company, Inc.
67 Wall Street INCO New York 5, N. Y.

INCO NICKEL ALLOYS

ABSTRACTS
(Continued from page 22)

AUSTEMPERING TYPEWRITER PARTS

R. S. McFall
Project Manager
Machinery & Process Division
International Business Machines Corp.

An integrated, multiple-stage heat-processing machine austempers electric typewriter type bars to uniform metallurgical characteristics and close dimensional accuracy at high production rates and without rejects. Installed at the International Business Machines Corporation plant at Kingston, N.Y., this automatic unit has reduced manpower 40 per cent and materially reduced nonproductive down time.

The heat-processing machine designed and built by Selas Corporation of America, forms a logical segment of the work flow. It is located, not in a separate heat-treating shop, but in the metal-working area close to the press which stamps out the workpiece. Parts handling is simplified accordingly.

Efficient heating with minimum heat loss to the surrounding area makes this arrangement possible. This high thermal efficiency is indicated by the fact that the high temperature section of the machine is mounted directly on a hardwood floor.

The parts treated are type bars for IBM electric typewriters. The type face is subsequently soldered to this type bar, thereby forming the lever which actually strikes the ribbon, and produces the impression on the paper.

The high-operating speed of electric typewriter type bars requires a hard, tough structure and a flat shank. These requirements are embodied in the specification of hardness Rc42-44, shank flat ±.001 in.

The type bar is about 4⅝ in. long, 9/32 in. wide, and 0.040 in. thick, stamped from AISI 1040 steel and bent at one end. Since all the type bars in a typewriter form a segment of a circle when at rest, but each must strike the paper in a vertical position, the bar is press-formed to a different angle for each character. At least 42 such shapes are required for each IBM electric typewriter.

Required hardness and flatness are developed by heating the parts for hardening, and quenching them in an elevated temperature bath, resulting in the isothermal transformation which is known as austempering.

When IBM moved its typewriter manufacturing operation to a new plant near Kingston, the company determined to increase efficiency by automating processes wherever practical. Type-bar austempering was one of the processes selected for increased mechanization.

In developing the new equipment, production engineering and process development engineers critically examined the austempering process. They determined that a fixed time of treatment was required only in the isothermal quench and that the initial heating and subsequent cleaning operations could be shortened without adversely affecting the quality of the workpiece. It was therefore decided that the type bar should be initially raised above the austenitizing temperature by passage through a furnace operating at a high temperature gradient, quenched by quick, direct transfer—without coming into contact with room air—into a conveyorized salt bath maintained at the proper temperature, and then washed to remove the salt. Bars were to be delivered completely treated, clean, dry, and at room temperature.

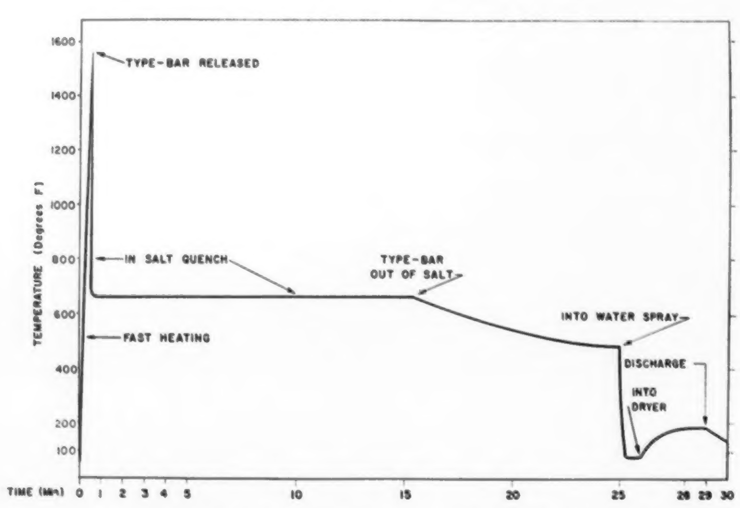
Pilot Run

The process was resolved into a basic time-temperature cycle in the vendor's laboratory using a simplified furnace, and carefully checked by a pilot run of several thousand bars.

The time-temperature curve developed as a result of the laboratory investigation was then used to produce an integrated equipment design.

This principle of furnace construction and operation, known as Gradiation, offers several operating advantages. Three factors in combination protect the surface of the workpiece: (1) controlled combustion of a rich gas-air mixture to produce a slightly reducing atmosphere, (2) tight furnace construction plus positive furnace pressure to prevent infiltration of excess air, and (3) total time of workpiece exposure to the heat measured in seconds. Fast start-up permits shutting down the furnace over holidays, while low fuel consumption

(Continued on page 46)



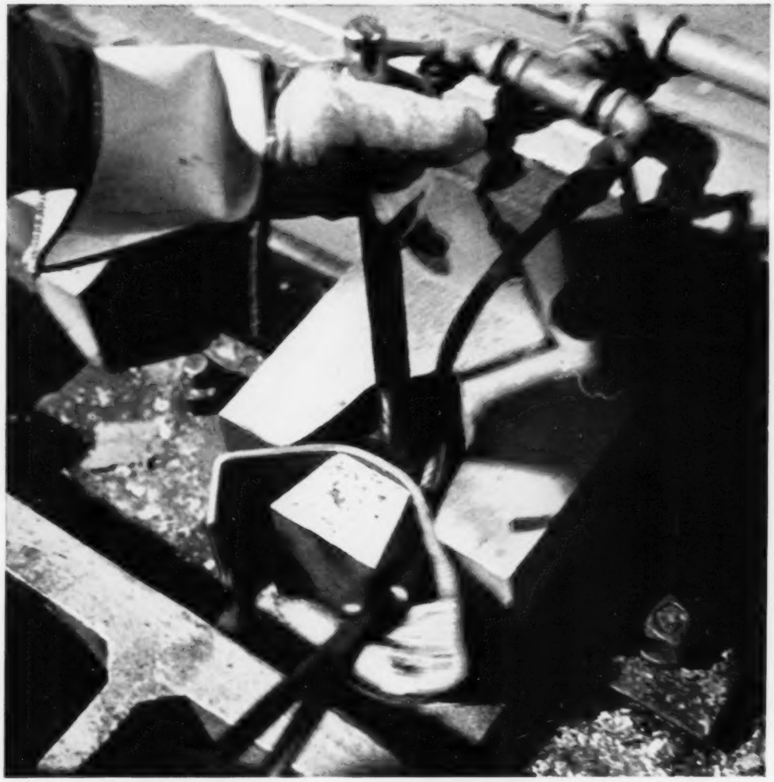
Heat-processing cycle, shown in time-temperature curve, evolved from pilot runs in vendor's laboratory.

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Highway Guard Rail Brackets Formed Red-Hot with Cromo-W

The product is a steel offset bracket, ¼ in. thick. It's used for fastening wire rope to highway guard rail posts. The bracket is formed red-hot, with a two-stage die of Bethlehem Cromo-W tool steel. Between 90,000 and 100,000 pieces are produced before redressing becomes necessary.

Cromo-W has a 5 pct chromium content and is one of our most popular general-purpose tool steels for a variety of hot-work applications. It offers good red-hardness and high shock-resistance. It also has good resistance to heat checking when cooled drastically during high-temperature operations, and is easy to machine and heat-treat.

Cromo-W is an ideal grade of tool steel for such diversified uses as die casting dies, bolt-gripper and bolt-header dies, trimmer dies, punches, and hot shear blades. In fact, it's a grade you can count on for long service in virtually any manufacturing operation involving severe shock and temperature change.

Typical Analysis

Carbon 0.35	Tungsten 1.55
Silicon 1.05	Molybdenum 1.65
Chromium 5.15	

In addition to Cromo-W, Bethlehem offers Cromo-WV and Cromo-High V for die casting and extrusion work. See your Bethlehem tool steel distributor for full details on these fine hot-work grades.

General view of the forming operation. Cromo-W is ideal for this hot-work application because of its good red-hardness and high shock-resistance.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Machining is a Tearing Operation

Close examination of the surface of a machined part, or chips machined from it, indicates the presence of countless minute tears. Generally, the tears can be seen most readily on parts machined at low speeds, with heavy feed and depth of cut. However, they are also present in all machined surfaces, even though not readily visible. The depth of surface tears on smooth machined tools and dies may be approximately one thousandth of an inch, or less. For this reason, the presence of the tears and their possible effects are often overlooked.

Most tools are heat treated after machining. Then they are ground all over to produce the exact dimensions, and to remove scale or decarburization resulting from the hardening operation. This procedure automatically removes tears in the surface previously produced during machining. However, many tools are ground only on certain portions, with the balance of the tool surfaces containing the remains of the machining tears, plus heat treatment scale and decarburization. This condition occurs often when you grind only the actual working surfaces which make contact with the parts. Tools produced by this method are more susceptible to failure in service because of stress concentration produced by the sharp change of section in the tears. This is particularly true of tools subjected to a large number of stress cycles in service, such as pneumatic tools.

Grinding all previously machined surfaces of tools after hardening is an operation which helps improve production from the tools. Grinding before hardening will also be effective, should grinding after hardening be inconvenient.

M.T.I. ACTIVITIES

(Continued from page 20)

improve the industry they represent, and thus to serve the public.

MTI-ASM HEAT TREATING SESSION

Members of the Metal Treating Institute are participating for the first time this year in a jointly sponsored technical session as part of the 40th National Metal Exposition and Congress being held in Cleveland, Ohio, during the week of October 27-31.

The technical session on the morning of Thursday, October 30, in the Hotel Cleveland, will be devoted to the subject of "Heat Treating" and members of the MTI are scheduled to present the following papers:

"Limiting the Distortion of High Strength Steels with Simple Tempering Fixtures" . . . by Fred Heinzelman, Jr., Fred Heinzelman & Sons, New York City.

"The Heat Treatment of Metals in a Vacuum" . . . by R. C. Gross, Kinetics Corporation, Hingham, Mass.

"Expected Variation in Hardenability of AISI-4142 Steel" . . . by Charles F. Lewis, Cook Heat Treating Co. of Texas, Houston.

"Mysterious Failures in Heat Treating and Their Solution" . . . by Horace C. Knerr, Metlab Company, Philadelphia, Pa.

Chairman of the session will be Mike Soviack, of Commercial Steel Treating Corp., Detroit, Mich.

REMEMBER!!

Annual Meeting
Metal Treating Institute

Hotel Cleveland

October 30 — November 1

ABSTRACTS

(Continued from page 44)

in combination with 20-min recovery time makes idling of the furnace, as through the midnight shift, an economical procedure.

The salt quench furnace, into which the type bar is dropped after reaching 1550 F, is the largest component of the austempering line.

The salt quench bath is contained in a welded steel pot set into a specially-designed furnace. The salt pot is completely enclosed to prevent dangerous splash of hot salt, and to minimize heat loss. Heat is supplied by two rows of Duradiant burners firing at close range, one row on either side of the pot. Twin, propeller-type agitators provide temperature uniformity within 2 F throughout the salt bath. Salt temperature is automatically-controlled by regulation of the fuel mixture pressure in the burner manifolds.

The type bar is held in the salt bath for 15 min., spending about 10 additional minutes on the salt quench conveyor. It then falls through a recirculating water spray to clean off the dried salt, and is carried up a belt-type conveyor and deposited into a dryer.

The dryer employs circulating warm air to remove the moisture from the type bars; the air being heated by a spark-ignited direct-flame gas burner. The dryer, unusually compact for this operation, measures only 56 in. high by less than 55 in. long. The type bars are delivered clean, dry, flat and uniformly hardened and toughened.

Once the furnace is lighted and at temperature, except for loading the type bars, the operation is fully automatic. Fuel gas is mixed with air in controlled proportions by a combustion controller. This device incorporates a sleeve-type mixing valve which holds the preset fuel to air ratio despite large variations in demand. An integrally-mounted compressor pressurizes the fuel mixture for delivery to the burners.

Handling is completely automatic after manual loading of the type

bars onto the support fixture of the high heat conveyor. This conveyor is a horizontal pinwheel equipped with heat resistant chrome nickel alloy fixtures. One type bar is loaded in the vertical position at the extreme end of each radial pin and is carried from the loading area into the high temperature furnace.

This furnace is shaped to conform to an arc of the circle through which the type bars travel. Each type bar is heated to 1550 F in 25 sec., then is released from the fixture to drop through a tube from the floor of the furnace into the salt bath.

The high temperature furnace is fired by Duradiant burners set in the outer refractory wall. Each burner consists of a ceramic cup in which a controlled mixture of natural gas and air is burned. The flame wipes the cup, bringing it to incandescence, resulting in high intensity radiation of thermal energy to the workpiece. Combustion is virtually completed within the cup, preventing flame impingement on the workpiece although the burners fire directly at the type bars at a distance of only four inches. Burners are placed in horizontal rows in a pattern engineered to produce a uniform temperature throughout the type bar by the time it is released for quenching.

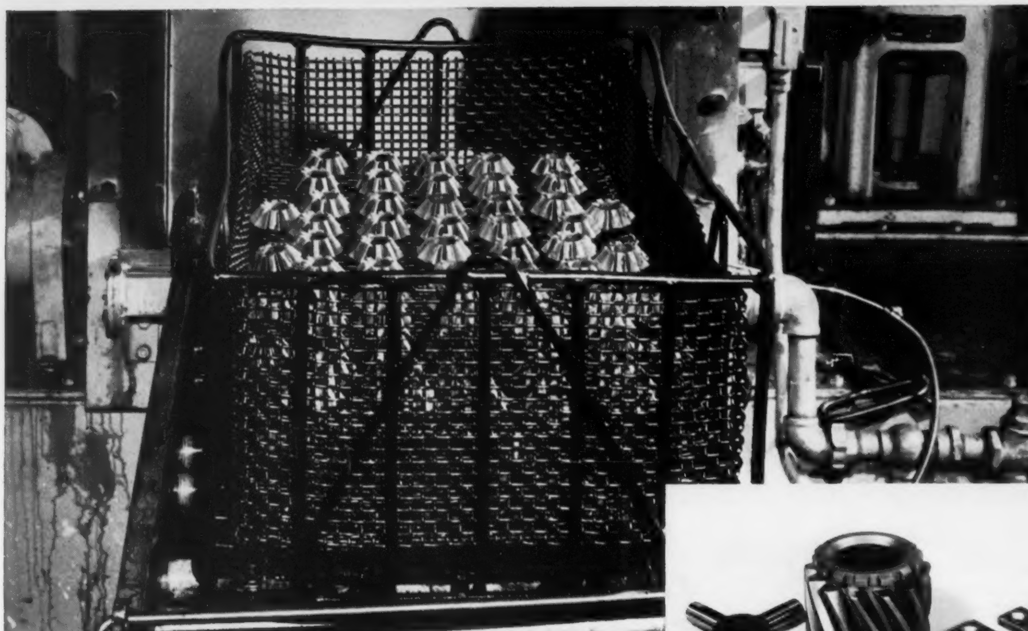
Close to the heat-processing machine is a motor and temperature control center. A thermocouple in the high-temperature furnace chamber controls the initial heating. A recording controller supplies a signal to a motorized valve modulating the gas-air input rate to the burners. A similar recording controller indicator, serviced by a submerged thermocouple, controls the temperature of the salt quench. As an additional safety feature, another indicating controller is operated from a separate thermocouple in the salt quench furnace to prevent overheating under unusual or abnormal conditions. The temperature-control system is completed by an indicating controller which regulates the temperature of the circulating air in the dryer.

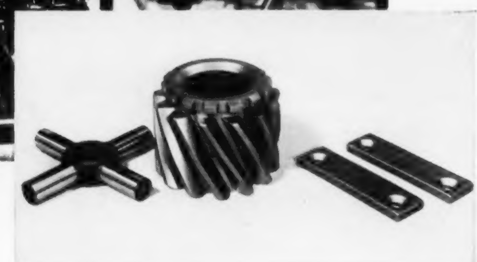
Salt bath burners and dryer burner are spark-ignited from the control panel through an automatic purge cycle control, which eliminates the hazard of possible flammable vapor accumulation. All the motors in the heat-processing system are started and stopped from a cluster of push buttons close to the temperature controls, with pilot-light indicators to monitor operation.

The motors include the combustion controller, two water pumps, the furnace, salt, wash and dryer conveyors, the salt mixers, and the dryer blower.

The type bars as received reveal under the microscope a thoroughly spheriodized structure. After treatment, micro examination reveals a tough, fine-grained Bainite structure. • • •

Source: Selas Corporation of America reprint from "PRODUCTION" magazine





(Above) This unretouched photograph indicates the cleanliness of rear axle differential pinions when Voluta Oil is used. (Right) Differential spider, two-speed helical pinion and spring wear plates were all quenched with Shell Voluta Oil.

Here's a stable, high-speed quenching oil that minimizes work distortion

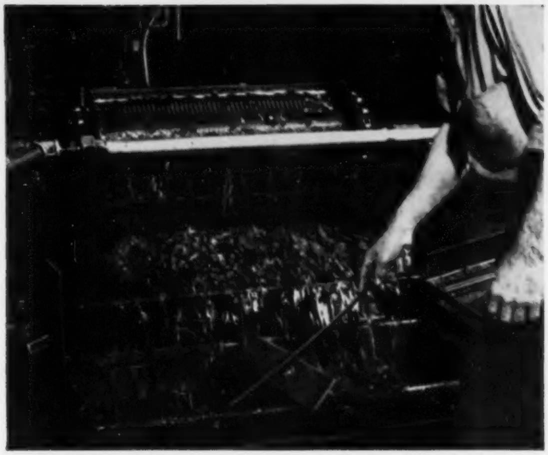
There has long been an urgent need for a uniformly stable quenching oil that would perform satisfactorily with minimum distortion of the workpiece. During the quenching operation, fluid deterioration can occur, causing sludge and acid formations which in turn result in non-uniform physical characteristics of quenched parts.

An efficient and timely answer to this industry problem is found in Shell Voluta Oils. They satisfy the two basic requirements of a high-quality quenching oil: 1) They remain stable at temperatures much higher than heretofore allowable, with no appreciable sludge formation. 2) They permit safe, rapid quenching of parts which have a tendency to distort. This is in part due to the higher permissible fluid temperatures, and also to the greatly enhanced wetting qualities of Voluta* Oils.

There are many applications that clearly demonstrate the efficiency and versatility of Voluta Oils.

One example relates to a leading producer of several thousand varieties of axle parts. With conventional quench oils, rejects were high due to unfavorable stress concentration and subsequent cracking. After changing to Voluta Oil, maximum uniformity was achieved because of Voluta's superior wetting-out properties and stable cooling rate. For heat-treating purposes, Voluta Oils proved stable at temperatures from 130° to 200° F. They also provided greater surface hardness, depth of hardness and uniformity.

A well-known manufacturer of automotive steering units was faced with a similar situation. Here the problem involved heat-treating low-carbon-steel parts as well as grey-iron castings. Although they were of widely varying materials, shapes and sizes, this company found that



Shaker hearth furnace automatically dumps parts into Shell Voluta Oil, then removes and drains them.

Over 35,000 prints of production items like these (quenched in Voluta Oil) are kept on file by one leading steel spring manufacturer.

Voluta Oil was far superior in all these ways: 1) longer life; 2) clean, scale-free parts; 3) wider range of quench temperatures; 4) no rejects due to distortion; 5) no sludge formation.

Still another case occurred during the manufacture of many thousands of different shaped springs. This company wanted to insure maximum elasticity of their springs, and to achieve this a 100 per cent martensitic structure had to be maintained. Tested in competition with several other quench oils, Shell Voluta Oil again proved superior because it resulted in the production of distortion-free springs, and allowed quicker drainage and minimum dragout loss.

Another feature: Voluta affords substantial savings on a yearly basis . . . and it further proves its economy in reduction of rejected parts.

Perhaps you have a similar quench problem . . . or any quench problem, for that matter. It would be to your advantage to call or write your nearest Shell Oil office. We'd be glad to have our representative discuss your particular quench problem and methods to help overcome it.

*Registered Trademark

Parts are heat-treated and quenched in two-zone hardening furnace while Voluta Oil's temperature is closely controlled.

Castings and low-carbon-steel parts for hydraulic steering units are all processed through the same heat-treating furnaces and quench tanks.

SHELL OIL COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

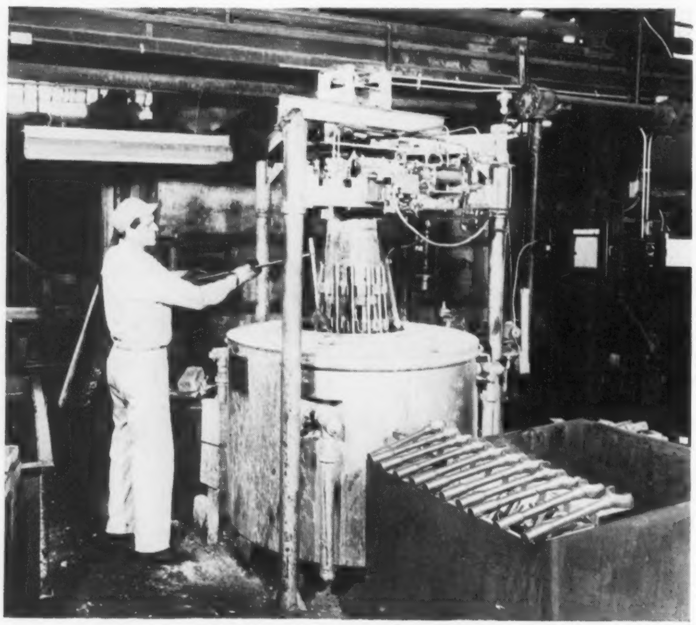
NEWS TO HEAT TREATERS
(Continued from page 42)

SELECTIVE HARDENING AXLE SHAFTS

A midwestern manufacturer has solved the problem of heat treating yoke-type axle shafts to selectively harden 3" of the yoke end. This Surface Combustion Standard Rated Lead Pot Furnace offers a mechanized process at a relatively low investment.

An automatic rotating mechanism holds the axle shafts so the yoke end is immersed to the desired depth in the lead pot. The axle shafts rotate counterclockwise to permit the operator to load and quench parts from the same station. Production rate is 120 pieces per hour with a heating time of 7.7 minutes.

For further information circle No. 15

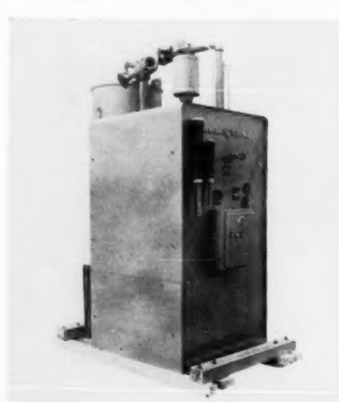


EXALENE GAS PRODUCERS

New low-cost Exalene gas producers for use in the manufacture of rich or lean exothermic protective gas atmospheres have been introduced by General Electric's Industrial Heating Department.

Fully portable to facilitate moving and installation, the compactly designed units are partially filled with catalyst brick to help assure complete reactions. Low initial, operating and maintenance costs of the new gas atmosphere equipment make it ideal for producing rich and lean gas necessary in treating certain metals, according to company engineers. Low thermal conductivity of both gas mixtures minimize thermal losses from the easily operated and maintained furnaces.

Rich exothermic gas, used in protective atmospheres for ferrous and non-ferrous metals, is moderately reducing to oxides of iron and copper at elevated temperatures, and excellent for bright annealing, normalizing, hardening, furnace brazing and sintering, the engineers said. The rich mixture normally produces clean, bright work, but will decarbonize medium- and high-carbon ferrous metals.



Lean exothermic gas is normally used for bright annealing copper; annealing brass and bronze; silver brazing copper, brass or bronze; prevention of oxides in storage of paints and varnishes; bubbling batches of synthetic resins, varnishes and bodying oils during cooking; and for protection against oxidation of fruit juices in cans. Other uses for the lean mixture are for fire prevention and extinguishing in the paint and varnish industry and for prevention of explosions in a variety of dusts or finely powdered materials in the drug, chemical and other industries.

Exalene (exothermic) gas is produced by reacting a hydrocarbon fuel gas (coke-oven, natural, propane or butane gas) with air over a catalyst at high temperature. About 50 percent of the amount of air required for complete combustion gives lean Exalene gas.

The gas producers consist of a self-heated reaction chamber partially filled with catalyst brick. The units operate at 1800 to 2400 F (982 to 1316 C). Accessories are provided for measuring, adjusting, controlling, and compressing the input air and gas mixture. Safety features for gas or power failure and flashbacks and a surface cooler with a water separator and trap to partially remove moisture from the Exalene gas are other features.

For further information circle No. 16

UNIT DRAWS AXLE FLANGES

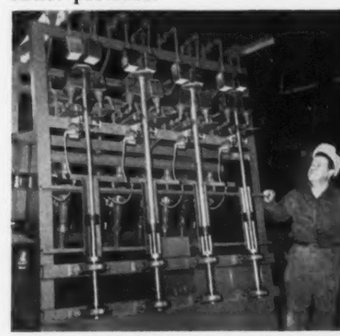
In order to prepare truck axle shaft flanges for machining and drilling after the shafts have been hardened, Gas Appliance Service, Inc., 1940 West Balmoral Avenue, Chicago 40, Illinois, designed and built a Four-Station, adjustable "Flame Draw" Unit for International Harvester's Ft. Wayne, Indiana, motor truck plant.

The gas-fired unit heats the flanges of the previously hardened
(Continued on page 52)

NEWS TO HEAT TREATERS

(Continued from page 50)

pieces to 1400°F. without allowing heat to creep into the shaft. Four "Zig Zag" rapid heating, internal combustion type burners, that combine high flame temperature with maximum heat output, are installed at each station. A Furkert Gas-Air Mixer supplies the accurately premixed gas-air mixture at 32 oz. outlet pressure.



As the shaft is inserted at each station, it actuates an automatic timer, which causes the burners to go on "high fire"; at the end of the pre-set heating cycle, the timer throttles the burners and flashes a signal light. The shaft is then removed by the operator, and replaced by another shaft. The heated shafts are allowed to cool in air.

The new unit is said to be flexible in operation, will accommodate a wide range of shaft and flange diameters, as well as axle lengths, and will handle from 75 to 125 axle shafts per hour, depending on the shafts per hour.

For further information circle No. 17

AMMONIA CYLINDER PLANTS

Three new anhydrous ammonia cylinder filling plants have been opened by the Ammonia Division of Armour and Company bringing the total number of Armour Ammonia plants in the nation to fourteen. The new plants are located in Los Angeles and Oakland, California and East Liverpool, Ohio.

The Los Angeles and East Liverpool operations will also include bulk tank truck facilities. The Oakland plant will be devoted exclusively to filling cylinders.

For further information circle No. 18

(Continued on page 55)

AT THE HOMESTEAD WORKS OF U. S. STEEL National Alloy Rollers carry USS "T-1" plate up to 45 feet long, 13 feet wide, and 2 inches thick through heat treating furnace.

AT LUKENS STEEL National Alloy Rollers have been in service more than 2½ years where plate up to 172 inches wide and 3 inches thick is heat treated.

National Alloy Rollers provide long service on Drever continuous plate Heat Treating Lines

Establishing better properties in steel plate through heat treating has become a continuous, high output operation at leading steel producers. As the leading specialist in high temperature, high alloy castings, National Alloy, cooperating with Drever, engineered, centrifugally cast and produced some of the largest high alloy rollers now in use to handle plate up to 3 inches thick and 172 inches wide. These rollers vary in diameter from 8 to 14 inches and are 20 feet long.

Meeting the ever-increasing demands of industry for high temperature, high volume equipment has given National Alloy unmatched experience in the development and manufacture of high alloy castings for maximum service. Consult National Alloy for a practical answer to your high temperature and high corrosion problems.

BLAW-KNOX

THE MARK OF QUALITY NA NATIONAL ALLOY

BLAW-KNOX COMPANY

National Alloy Division, Pittsburgh 38, Pennsylvania

LETTERS TO THE EDITOR

Gentlemen:

Will you please send us one (1) copy of the September-October, 1957 issue of the "Metal Treating" Magazine. We seem to have misplaced our copy of this Magazine and are in dire need of same.

We are planning to use the article on heat treating of aluminum for a training program of our shop personnel.

R. A. Matuszeski, Supervisor
Development & Test Laboratory
Nuclear Energy Products Div.
ACF Industries, Inc.
Albuquerque, New Mexico

Dear Editor:

After reading Mr. Haig Solakian's articles on "Salt Baths and Salt Bath Furnaces", the writer is wondering if you could be so kind as to send a copy of the January-February and March-April issues to Mr. A. Bakewell, Technical Director; Qualcut Tools Limited; Workshop Road; Attercliffe; Sheffield, 9, England. I am sure that he and perhaps other members of this high speed drill manufacturing firm will find these two articles on Salt Bath Heat Treating of much interest, and quite possibly if you can send them complete copies of your magazine, some business may result to one or more of your advertisers.

Would send them our own copies of your fine publication, but we value them too highly to part with any copies.

James H. Griffin
Distributor of Tools
Akron, Ohio

Gentlemen:

We have recently received two back issues of "Metal Treating" per request of our Mr. R. Lobsiger. In going through these issues we have found some very interesting articles but we have not been able to find the price of a subscription to same. We would appreciate your furnishing the necessary information so that we may subscribe to this very interesting and helpful magazine.

Yours very truly,
N. G. Gruse, Purchasing Agent,
Phillips Drill Company
Michigan City, Ind.

Dear Editor:

In my opinion you are performing a very worthwhile service by publishing your "Metal Treating" magazine. The main articles are well written and present valuable information for the engineer concerned with metallic parts production.

I am a planning engineer with the Western Electric Company and would like my name added to your mailing list.

Sherman H. Kaufman
Planning Engineer
Western Electric Co.
Winston-Salem, N. C.

Gentlemen:

Kindly send us information as to how we may obtain a subscription to your magazine entitled "Metal Treating". We would also

like to know the cost per year for the magazine.

Thank you.

C. H. Palmer
Chief Metallurgist
Diesel Equipment Division
General Motors Corporation
Grand Rapids, Mich.

Gentlemen:

I would greatly appreciate having my name placed on your mailing list for receipt of your magazine "Metal Treating."

B. S. T. Friis
Metallurgist
National Pneumatic Co., Inc.
And Holtzer-Cabot Divisions
Boston, Mass.

Gentlemen:

We have recently completed a survey of the periodicals which we feel would make a contribution to our research and development programs. "Metal Treating'' would make definite contributions to these programs.

We would greatly appreciate being placed on your mailing lists to receive future issues of this periodical and, if possible, back issues from January 1, 1958 to the present.

A. R. Weldon
Assistant to the General Manager
Florida Research and
Development Center
Pratt & Whitney Aircraft
United, Florida

Dear Sir:

I am teaching an Industrial Arts General Metals program in the Princess Anne High School. Metal forming is one of my instructional areas, and I would like to receive your publication "Metal Treating" as a source of material for the material presented in the course.

Parker R. Johnson, Jr.
Lynnhaven, Va.

Gentlemen:

I had the opportunity to study an issue of your publication "Metal Treating," and I would greatly appreciate your placing my name on your mailing list.

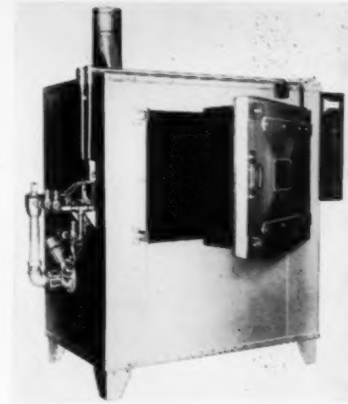
Emmons Robinson
Heat Treat Foreman
Fellows Gear Shaper Co.
Springfield, Vt.

NEWS TO HEAT TREATERS

(Continued from page 52)

RECIRCULATING FURNACES

A tested standard line of 1000°F. recirculating furnaces has been announced by the Grieve-Hendry Co., Chicago, Ill. These units were designed specifically for Solution Heat Treating and similar processes. With Potentiometer-type temperature controller they meet Mil Specs. Standard models are available for either electric or gas heat. Oil-fired units are supplied on special order, as are 1250°F. units.



The model shown is a Gas-Fired Furnace. Work chamber dimensions are 38" wide x 20" deep x 26" high. Over-all dimensions are 56" wide x 32" deep x 63" high. A 150,000 BTU gas burner is installed.

For further information circle No. 19

The
Metal Treating Institute

Annual
Achievement Award

The award is made at the discretion of a Committee appointed to select the Best Article appearing in METAL TREATING magazine or Lecture presented at any meeting of the Institute.

This year's award shall be presented at the 1958 Annual Meeting of the Institute, and all Articles appearing in any issue of METAL TREATING from September-October 1957 to July-August 1958 or any Lectures presented at the 1957 Annual and 1958 Spring Meetings are eligible for consideration.

AWARD COMMITTEE—

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Members, Publication Committee

C. E. Herington, *Editor, METAL TREATING*

HEAT TREATING HINTS

(Continued from page 30)

hemispheres with a new-type hot-spinning machine, which moves a special hydraulic yoke up and down on the axis of a great circle and exerts up to 12 tons of controlled pressure in forming precision parts with varying thicknesses and diameters. Appropriate tools are added to the spinning machine to scarf or contour the edges of formed hemispheres so that they can be welded.

Welding consists of mating pairs of hemispheres in a chamber with inert atmosphere and semi-automatic heliarc facilities. Purpose of this is to prevent oxidation, avoid the inconsistencies of hand welding, and yet allow variations in operating conditions which are conducive to best results. (See Fig. 1).

After being welded, each pressure vessel is annealed, quenched and aged in a custom-built electric furnace which has a 42"-diameter, 42"-deep work area and accessories which allow the protection of titanium with inert gases.

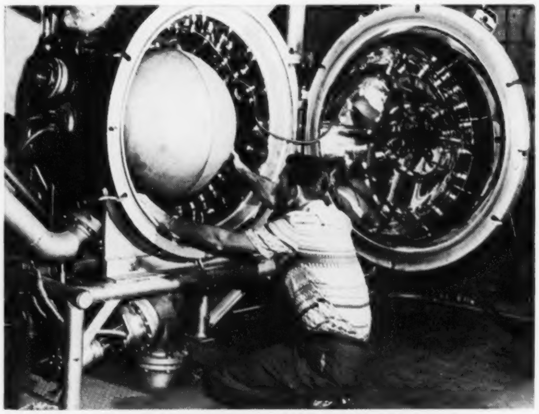

Fig. 2—Titanium pressure vessel is mounted on horizontal axle-type fixture in custom-built electric heat treat furnace.

Because it can maintain temperatures up to 1750° F. ±25° F., the latter furnace can produce all of the conditions that are theoretically necessary to obtain 150,000 to 190,000 p.s.i. ultimate strength and 130,000 to 180,000 p.s.i. yield strength in 6A1-4V materials. However, Titanium Fabricators are currently using soaking temperatures of 1500° to 1700° F. for periods ranging from 30 minutes to 1 hour.

During each heat treatment, a pressure vessel is mounted on a horizontal axle-type fixture as indicated in Fig. 2. This prevents distortion by allowing uniform thermal expansion.

Following the treatment, distortion is minimized by using sprayed water to quench the titanium component. This of course prevents non-uniform contraction by simultaneously reducing temperatures in all heated areas.

Aging of the pressure vessels is accomplished by holding temperatures of 800° to 1000° F. for 4 to 10 hours. • • •

(Continued from page 18)

and attacking the surface to a considerable depth. Some of the more highly alloyed tool steels require a higher acid concentration than do the plain carbon or low alloy varieties for the same effect. The proper conditions for a given steel can best be found by trial.

Although cracks in hardened steel can be detected by etching, the magnetic particle method is to be preferred since it is much more reliable, especially if Magnaflux equipment is used; moreover, it is completely nondestructive. Etching as a method of crack detection is a rather poor substitute for magnetic particle inspection but is extremely useful for indicating the presence of burn.

Hot hydrochloric acid has been used in the past for detecting cracks in ground surfaces of hardened steel, but this acid, as well as hot or cold sulphuric acid, should not be used for this purpose because the results may be ambiguous and easily misinterpreted. The trouble with these acids is that they not only widen cracks already present in a ground surface of hardened steel, and thus make them readily visible, but they are also capable of creating entirely new cracks if the surface is highly stressed in tension. These newly formed cracks are called *etch cracks*.

Hydrochloric and sulphuric acids should be reserved for the detection of high stresses by means of etch cracks, and should not be used for the detection of cracks that are already present. If cracks have to be detected by etching because the magnetic particle method is not available, then one of the nitric acid etchants discussed above should be employed, for these cannot cause etch cracks to form. The proper use of hydrochloric and sulphuric acids will be taken up in the section on the detection of stresses. • • •

(To be continued)

(Continued from page 6)

strength of only 2000 to 3000 psi at a temperature of 1800 to 2000°F.

The pumping system itself can best be designed with the aid of equipment manufacturers. For large installations, it has been our experience that automatic temperature control for the diffusion pump is essential. Although there are some differences in terminology used by the equipment manufacturers, diffusion pump ratings are almost always based on the volume of air handled at an arbitrary pressure. Such ratings are difficult to interpret. For example, a booster-type diffusion pump may have a pumping rate of 5000 cfm at 5 microns pressure, and this sounds like a large capacity. However, remember that this is only .03 cfm at atmospheric pressure. In considering the amount of gas contained in some metals, such a pump might be entirely too small. If you want to use your vacuum furnace for degassing, you want to remember that the air rating is much greater than the hydrogen rating as illustrated by Figure 3.

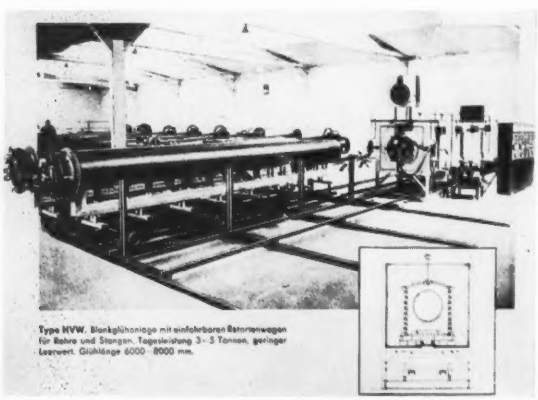

Fig. 5—Vacuum-Heraus (Germany) Vacuum Furnace, 1938.

The selection of vacuum gauges should be based on the applications intended, since these will measure the effectiveness of the pumping system. Thermocouple and alphatron-type gauges are frequently used because several gauges can be connected to a single instrument, and because they can be used with a recording instrument. By comparison with McLeod-type mercury gauges, they usually read high, but are adequate to indicate uniformity between various furnace cycles.

We consider that the reactive metals, titanium, zirconium and many others, should not be heat treated in any reactive atmosphere where the section thickness is approximately one-eighth inch or less. For the annealing of such metals, Superior Tube Company installed, in the Fall of 1953, a production size vacuum furnace shown in Figure 4 which accomodates a retort 10-inches in diameter and 24-feet long, capable of handling loads up to 1000 pounds. This furnace utilizes a 100 cfm mechanical pump and a six-inch booster-type diffusion pump. It regularly produces a vacuum on the order of .5 microns. In order to handle the volume of gas expected from large quantities of reactive metal tubing, the booster pump was selected in preference to the normal diffusion pump because of the very much larger pumping capacity. This booster-type pump has operated at pressures as high as 1000 microns as compared to an upper limit of approximately 200 microns for the usual oil diffusion pump. The resistance-type furnace shown here is divided into three zones, each with its own recording temperature controller. The retort can be pumped down to a few microns pressure in fifteen to thirty minutes, which is about the time required for the booster pump oil to come up to temperature. By using the by-pass valves, the diffusion pump can be held under vacuum by means of a small holding pump and, when operated in this manner, the pump-down time can be reduced to as little as five or six minutes.

Vacuum degassing of finished titanium alloy compressor blades has been accomplished satisfactorily in stainless steel fixtures. It is particularly important in designing furnace fixtures, that work be aligned so that there will be no baffle in a direct line with the pump. In this case, if the front blades were turned at right angles to the pump, the effectiveness in obtaining a bright anneal on the entire furnace load would be in jeopardy. In a bell or pit-type furnace, this should not be a severe problem.

Figure 5 shows a multiple retort system built about 1938 in Germany and used in regular production of wire and tubing ever since. This installation was made because of the relatively high cost of hydrogen and the unavailability of ammonia. In other words, the installation was dictated almost entirely by economic considerations rather than technical ones.

Figure 6 shows an example of the small double retort furnace for heat treatment of precipitation hardening alloys. A large horizontal-type furnace built by Westinghouse for Mallory-Sharon Titanium Corporation was pictured in *Metal Treating* for July-August, 1957. That particular furnace is 15-feet long by 9-feet in diameter with a working zone of 4′ x 4′ x 12′. Excellent temperature uniformity is obtained by four chromium-coated heating elements with reflecting shields located between the furnace walls and the heating elements. A KS-2000 diffusion pump in connection with the booster pump will evacuate the furnace to .1 micron pressure with an allowable leak rate of 10 microns per hour. A holding rack for material to be vacuum annealed was designed to hold ten thousand pounds. Normally, a load is heated to temperature in six to eight hours, held two hours at less than 10 microns, and cooled in six to eight hours by radiation and the introduction of argon.

It is certainly possible to convert existing furnaces

by the installation of a vacuum retort and pumping system or as shown in Figure 7. This furnace at Superior Steel Corporation is a converted Lee Wilson with a work chamber 42-inches ID by 84-inches deep and rated at approximately 8000 pounds.

Many people now have vacuum heat treating equipment; in some cases the heating elements being within the vacuum chamber while in others the heating furnace is external to the vacuum retort. In the latter case, cooling rates can be effectively increased by the use of air or water-cooled shells, while both types can be assisted during this cooling cycle by the use of helium or argon. There are now at least five furnaces which have a 10-inch diameter muffle of approximately 25-feet long; one of these was simply a type-304 pipe which was made into a vacuum retort and inserted into one of the ends of a car hearth furnace. This furnace is operating sastisfactorily and certainly illustrates a method of getting a vacuum retort into an existent furnace.

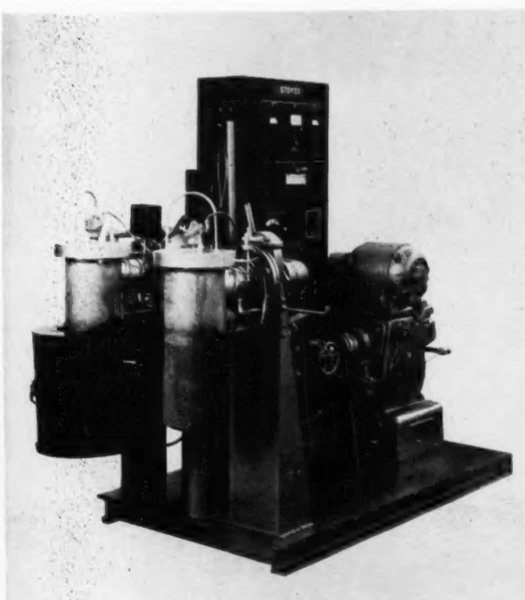

Fig. 6—Double Retort Vacuum Furnace for Precipitation Heat Treating of Small Parts.

While the furnace generally represents a major portion of the cost involved, one enterprising strip mill has evaluated the possibility of continuously vacuum annealing strip. While the method has been proved both in this country and in Europe, equipment costs are greatly increased because of the additional vacuum pumps and seals required. In previous years it was difficult to purchase a vacuum heat treating furnace since the vacuum equipment people were not familiar with furnaces and furnace manufacturers were very uncertain about selling vacuum equipment. This stage has passed, and one can now find suppliers almost by the dozen.

Applications

The application of vacuum heat treatment to more common metals is perhaps less spectacular than the degassing of titanium alloys or the annealing of titanium and zirconium, but has proven itself for its protective feature. Other metals include stainless steels, nickel and non-nickel alloys for electronic use and a number of precipitation hardening alloys such as beryllium copper, "K" Monel, Ni-Span-C, Elinvar and 17-7PH. The future will prove whether the demand for vacuum heat treating will grow along with the production of reactive metals and super alloys. Certainly the use of vacuum heat treating is a dependable way of retaining the effects of precipitation hardening elements such as titanium, aluminum and beryllium which are essential in the super alloys. For the precipitation hardening alloys used in watch springs and instrument diaphragms, vacuum heat treating has already proved that it will retain the effects of these elements even in the thinnest sections.

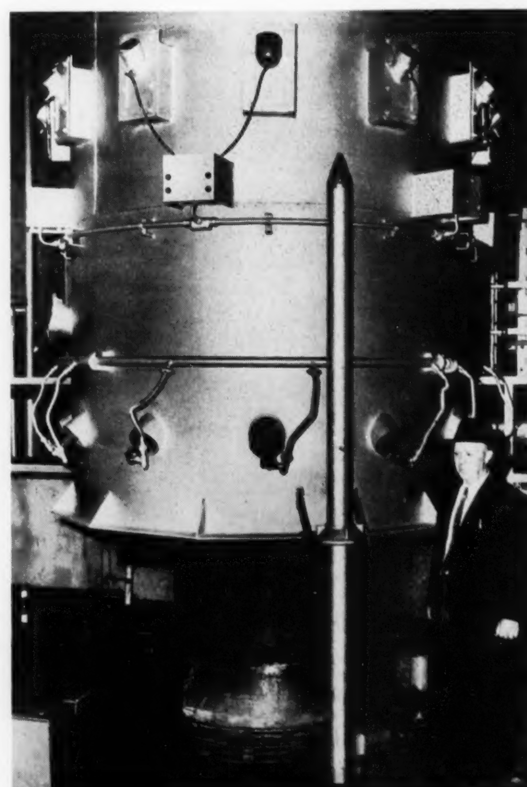

Fig. 7—Converted Bell-Type Furnace (Superior Steel Company).

Conclusions

The disadvantages of vacuum equipment in the heat treatment of metals are rather obvious ones, and it is not intended to indicate that vacuum heat treatment is a solution to every heat treating problem:

(1) Vacuum techniques are generally applicable only in batch-type work, although it is worth noting that continuous vacuum furnaces are a possibility.

(2) Heat transfer rates in vacuum are slow, particularly below radiant temperatures.

(3) The rapid transfer of work as required in quenching is somewhat difficult and cumbersome, although it can be accomplished.

(4) There are still difficulties in the accurate measurement of degree of vacuum and one is apt to find that three different instruments give three different readings on the same evacuated retort.

In production practice, vacuum heat treating techniques have proved indispensable in handling reactive metals and, in addition, have shown advantages in the treatment of many of the common metals—even including high carbon and alloy steels and stainless steels as well as essentially all of the precipitation hardening alloys. In many instances, the use of vacuum is actually less complex and is cheaper than the protection offered by prepared atmospheres, which often introduce the danger of poisonous or explosive fumes. Vacuum heat treating has long since left the laboratory and gone out into the shop; it is now simply a matter of getting used to handling a new set of tools and using them to the best advantage. • • •

"WHEN IT COMES TO POTS, OUR MEN HAVE DEVELOPED SOME HONIES!"

INDUCTION HEATING

(Continued from page 9)

with the flange end of each of the six shafts accurately located a few thousandths of an inch from its inductor. The hardening operation starts with static heating of the fillet area. Then the quench is turned on through the inductor, and the six shafts are moved at a carefully controlled feed rate down through the inductors for progressive hardening of their entire length. This operation is automatic with the exception of actual loading and unloading. Therefore, this cannot be called a fully automatic, unattended induction heating machine; it is only semi-automatic. All it does is harden

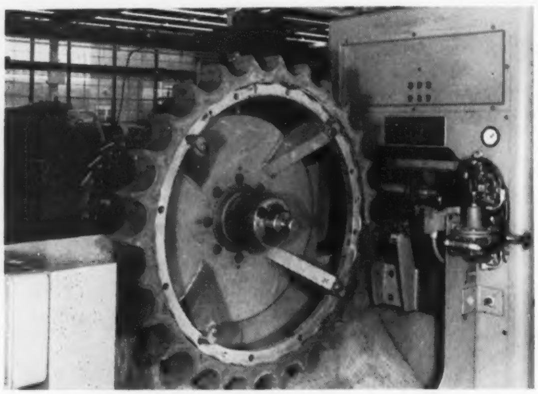

Fig. 3—Fixture for hardening large cast sprocket.

three different part numbers at the same time, with two of them coming along at random, with the operator only loading and unloading. Obviously, the elaborateness of a fixture, and therefore its cost, are dependent upon the type of application and the peculiar requirements of the customer's manufacturing methods.

Another factor to be considered in designing any induction heating fixture, whether automatic or not, is closely allied to the one of accuracy of part location; namely, the condition of the workpiece at the time it is to be processed. It is probably not finish machined. Usually there are further machining or grinding operations to be performed. A good example of this is in Fig. 3. The workpiece illustrated is a sprocket for a piece of earth moving machinery. The object is to harden the valleys between the teeth, one at a time, with the spiral pancake type inductor illustrated. It is a characteristic of this type of inductor that it must be positioned accurately relative to the work. However, even in its completed form, the surface of this workpiece is still a rough casting. There is no reason for it to be otherwise (except, perhaps, to provide a locating means for induction hardening). So there was no satisfactory locating point to use except the surface to be heated itself. Here, again the result was a fixture which must be called semi-automatic, as there is an operator to load it and to push a button. Then the fixture moves a valley into position adjacent to the inductor, heats, quenches, moves the work back, indexes, and moves the next valley into position. This continues until all the areas on the entire sprocket have been hardened. The method of indexing from one valley to another is suggested by the toothed wheel in the background. Lateral location is fixed by the limit switch arm which can be seen protruding through the center turn of the coil. In moving forward toward the coil, the workpiece strikes this arm, and is accurately stopped in the correct position relative to the inductor. In this case, then, the location of the workpiece relative to the inductor is actually measured from the very area being heated.

Fig. 4 illustrates an outstanding contrast with Fig. 3 from the standpoint of finish machining, and availability of locating means for the induction hardening operation. This application is the internal surface hardening of the side walls and the annular shaped inside ends of trunnion cups such as are used in large quantities in conjunction with needle bearings and spiders for automotive universal joint assemblies. The parts are heated and quenched while still in an automatic lathe, and while they are still attached to the bar from which they were turned. Heating time is less than one second, and the hardness does not penetrate the relatively thin wall. Distortion is so low and the condition of surface is so satisfactory after hardening, that no further operations are generally required. In some cases, the cutoff operation for severing the cup from its parent bar is going on simultaneously with the hardening. Admittedly, this is an ideal case for the induction heating fixture designer.

In applications of heating for forging, such as illustrated in Fig. 5, there is no question but that the parts are not finished—else why heat them? For jobs of this sort, through heating is usually desired, and slight variations of workpiece diameter are not so serious as they

Fig. 4—Induction heating applied to automatic machine tool.

would be in a close-coupled heat treating job, where the hardened pattern must be held within close tolerances. However, there still are some problems. It is unquestionably easier to handle and to push columns of slugs with cleanly cut sawed ends than parts which have been sheared and possibly bent.

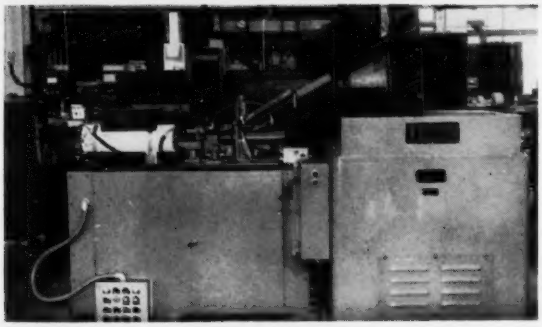

Fig. 5—Completely automatic slug heater for forge heating.

Closely related to the foregoing problems is how to hold the part in the first place;—that is, where to contact it with locators. Usually the most practical and reliable locating points are the ones from which the workpiece was held during the machining operation which created the area to be heated. It is evident that if the hardening fixture holds the workpiece from the same locating areas that were used during machining, there is a better chance of maintaining uniformity of positioning than if some other method of location is used which at first glance may seem simpler. Sometimes there seems to be no other way than to locate a workpiece from the same area that is to be heated. One method of accomplishing this was shown in Fig. 3, where the workpiece was a casting. Another method is to establish the position of the workpiece by first forcing the surface against a stop and then locking the part in position on a mandrel, moving the stop out of the way, and then moving the workpiece and the mandrel into position relative to the inductor. This does not generally lead to the simplest imaginable fixture design.

Another factor to be considered in production fixtures is that induction heating coils have a tendency to heat any metal which happens to be close enough to them to be coupled magnetically. The optimum conditions for eddy current heating must be established between the workpiece and the inductor, while at the same time, just the opposite situation must exist between the fixture and the inductor. It is necessary to keep metal portions of the fixture out of range of the inductor, and sometimes it becomes necessary to break up, by means of insulating, closed electrical paths which would be tempting to induced currents. Sometimes it is necessary to force-cool portions of the fixture to prevent them from overheating. However, it is far better and more economical to prevent them from absorbing power in the first place. By the time it reaches the inductor, the cost of each kilowatt second has increased because of having passed through relatively expensive electrical equipment. It should not be wasted in unnecessary, or even harmful, heating of the surrounding structure.

Fig. 6 shows an excellent example of successful automatic fixturing. Several of the points made previously are illustrated here. The application is to surface harden all the working areas on a camshaft automatically, leaving the in-between portions soft. Various schemes were considered during the preliminary planning for the first such fixture which was built. The high production rate, and the large number of areas per shaft, eliminated the method of treating one area at a time. The cams are arranged in groups between bearings, and another possibility was to heat the several cams in each group simultaneously. However, this also entailed several handling operations per shaft, with the possible necessity of degreasing operations if the material were such as to require oil quench. Progressive hardening was proposed, but the cam noses protrude so much further than the heels that the feed rate and power had to be so low that the areas of the shaft which were to remain soft also came up to hardening temperature. The scheme which was adopted, and which is illustrated here, is basically quite simple. The incoming camshafts are shown in a sloping chute in the upper left part of the photograph. The particular shafts illustrated here have been machined, but similar machines have been built for shafts which are as cast, with the only machining operation the drilling of center holes. The chute is curved because the shaft diameter is slightly larger at one end than the other, and they do not roll in a straight line. The bottom shaft in the chute is picked up by a vertically moving pair of vees which lower it into position between a pair of retractable centers.

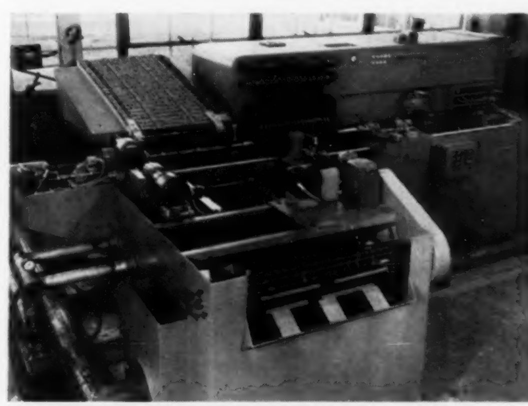

Fig. 6—Automatic camshaft hardening machine.

The illustration shows a camshaft in this position. The right hand center is on the end of a bar which extends all the way through a group of one-turn inductors. The centers then close on the camshaft, and the carriage, which is somewhat more than twice the length of a camshaft, moves horizontally to the right until the camshaft is properly positioned in the inductor assembly. All areas are then heated at the same time. The heated shaft is then moved to the left by the carriage, the centers retract, depositing it on the vees, and it is

(Continued on next page)

INDUCTION HEATING

(Continued from page 63)

quickly lowered into an agitated oil quench. The vees return to load another camshaft, and the process repeats automatically with no operator.

Several safeguards are built into this piece of equipment to prevent damage from malfunction or from improper workpieces. The feed chute has cleats which permit the shafts to be loaded only in the proper direction. They are hidden in Fig. 6 because the chute is full of workpieces. As the camshaft enters the coil assembly, it passes through an opening between some insulated copper leaves which are connected to a ground detector. If the center hole in the shaft is not correctly drilled, or if for any other reason, the shaft contacts these leaves, the carriage immediately stops. This feature has paid for itself many times over in terms of inductors which have not been destroyed.

The control of this machine is arranged so that no event can happen until the next preceding event has successfully taken place. If the control power or the hydraulic pressure should fail while the shaft is in the coil assembly, the centers do not retract, dropping the shaft onto the inductors. And just to make doubly sure, there is a ground detector which prevents any further automatic motions if anything is touching the inductor.

There are many more fine examples of successful automatic fixtures and machines for induction heating processes. Unfortunately, lack of space does not permit illustrating them here.

In conclusion, if an application meets certain requirements, induction heating is outstandingly suited to automatic fixturing. In any case, it pays to study the application thoroughly from all angles before—rather than after—building the equipment. • • •

HEAT TREATING "K" MONEL

(Continued from page 10)

±25°F. in a reducing furnace atmosphere. Then, after being soaked for 2 to 5 minutes, the metal is either water quenched or air cooled—the latter procedure being preferred where warpage must be minimized in thin sections.

After heat treating scale has been removed by the pickling or brightening operations described above, "K" Monel is now being *age hardened* by Convair in a furnace which can maintain a temperature of 1080° F. ±25°F. The latter temperature is held for a soaking interval of 16 hours. Then the temperature of the metal is reduced at the rate of 25° per hour until a temperature of 900°F. is reached, after which air cooling is allowable.

In order to avoid testing production parts or assemblies that have been heat treated, Convair incorporates two 4" x 9" samples in each batch of "K" Monel sheet prior to the aging process. The samples comprise 0.020" and 0.064" gauge materials and have 9" dimensions transverse to the direction of rolling in each instance.

If its heat treated samples have the aforementioned Rockwell hardness values, an entire batch of "K" Monel sheet is considered acceptable. In the event that they fail to meet minimum hardness requirements, the samples must be cut into tensile coupons and tested to destruction before the batch is either accepted or rejected. • • •

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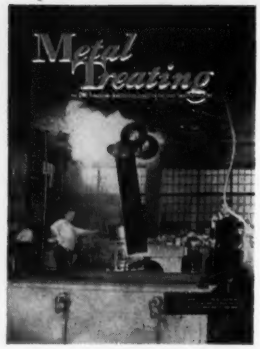
The only magazine devoted exclusively to the Heat Treating Industry



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HARDENING RACEWAYS

(Continued from page 3)

Hamilton Standard's Flamatic is capable of delivering a controlled mix gas flow of from 750 to 9,000 cubic feet an hour. The combustible gas used is propane which is combined with oxygen to produce the necessary thermal energy.

Parts other than propeller blade retentions have been processed in the flame machine, although the bulk of parts processed is blade retentions. Also, small parts of cylindrical shape even though they may not necessarily have a straight surface may be satisfactorily processed on the Flamatic.

Small parts to be processed generally are supported horizontally between centers, one center of which is driven by a Thyraton-controlled motor. Rotational speed of this center during the processing may be infinitely adjusted to from 30 to 300 rpm by simply adjusting a dial on the control panel. Speed adjustment is necessary so that the surface speed of the part being hardened will not depart too far from the recommended surface speed of 100 feet per minute.

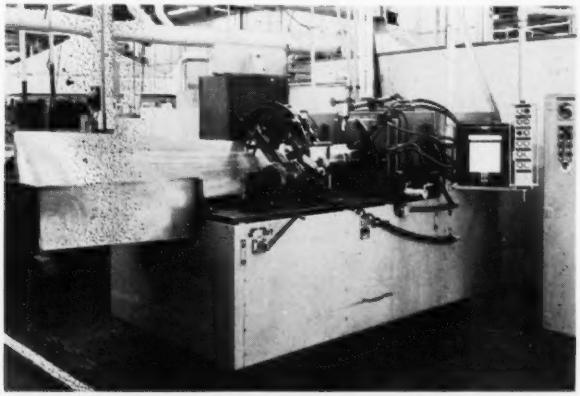

Fig. 4—Large propeller blade in position, ready for flame heating of blade retentions.

Control of the pre-determined heating cycle is accomplished by the same means as for propeller blade retentions. Since small parts are allowed to drop freely into the oil quench, as contrasted with the suspended blade, it is obvious that some method must be provided for removing the parts following the quench operation. This is done, for limited quantities of parts, by suspending a mesh-type bracket below the surface of the oil into which the parts may drop. The basket may then be removed on completion of the quenching operation. The hardening of large quantities of small parts which are not suspended in the quench oil is readily facilitated by using a conveyor belt system to remove the parts and deposit them in a container apart from the machine.

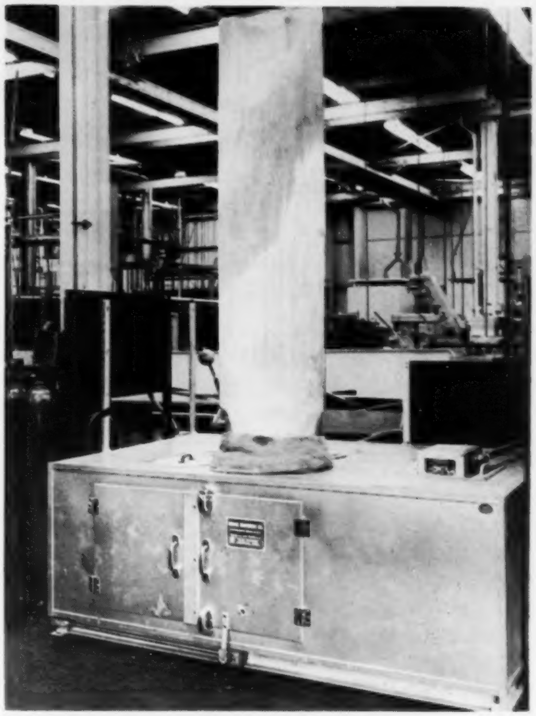

Fig. 5—Blade in stress relief oven after hardening operation. Oxygen bottles at left are part of a manifolding required for supplying oxygen necessary for combustion.

Case depth varies, depending on the function of the parts and the operating conditions. The case depth on blade retentions ranges from 0.150 inches below the bottom of the raceway for the small No. 2 shank blades to approximately 0.350 inches below the bottom of the raceway for the large No. 8 shank blades.

The flames are directed only at the bottom of the raceway. The sides of the raceway are heated by conduction, and by the effects of the so-called secondary flame envelope. (This is shown in Fig. 6 by the greater depth of pattern just below the bottom of the raceways).

Fig. 6—Hardness pattern is revealed by light acid etching in this longitudinal section.

The combination of accurately-located high temperature flames, precise control of surface temperature, and uniform quenching make possible a close control of the hardness pattern on the raceways. Hardness levels of the surface of the part being hardened depend on the carbon content of the steel used. The hardness of Hamilton Standard steel blade retentions, after hardening, falls within the range of 55-60 Rockwell "C". • • •

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

ELECTRIC HEATING ELEMENTS

The Refractories Division of The Carborundum Co., has published a booklet entitled "Hot Tips" which describes typical applications for Globar® Delta silicon carbide electric heating elements.

Typical applications for the elements include furnaces for heat treating, forging, sintering, brazing, annealing and others.

For further information circle No. 20

HARD COAT ALUMINUM ANODIZING

An improved process for hard coat anodizing of aluminum is described in a bulletin released by the Accurate Anodizing Corporation, Chicago, Ill.

Called the "Poracc" process, and covered by patents pending, it makes possible a more uniform aluminum oxide coating and substantially greater thickness of this deposit, when desired.

Because of these features, Accurate Anodizing Corp. states their hard coat anodizing imparts to customer's products improved wear and abrasion resistance, protection from corrosion, and greater dielectric strength.

For further information circle No. 21

HEAT TREATING: SHOULD YOU DO IT YOURSELF?

An 8-page, illustrated reprint of an article by this title which was first published in the magazine "Modern Machine Shop" is now available from the Metal Treating Institute.

Several important factors which manufacturers should consider in deciding whether to do their own heat treating or sub-contract it are discussed.

For further information circle No. 22

INSTANTANEOUS HEATING

A technical bulletin published by The A. F. Holden Co., Detroit, Mich., describes their Luminous Wall firing system. It is said to be a method of uniformly applying instantaneous heat to a part to be heated because it is a positive source of radiation, transferring heat directly to work being processed with negligible thermal storage in the furnace structure.

For further information circle No. 23

INDUCTION HEATING

The third issue of the "High Frequency Heating Review," published by Lepel High Frequency Laboratories, Inc., has now been published.

The issue contains stories on applications of high frequency induction heating, especially an article on Temperature Control. The 12-page booklet is well illustrated with schematic drawings and photographs.

For further information circle No. 24

CONTROLLED QUENCHING

Bell & Gossett Company, Morton Grove, Ill., have published an illustrated, 4-page booklet describing their equipment for controlled quenching where small pieces are heat treated. Schematic drawings, charts and diagrams are included.

For further information circle No. 25

TIME AT TEMPERATURE ALARM

The Herscott Co., Inc., Rockford, Ill., has published a brochure with illustrations and wiring diagrams for their new "Timalarm," a compact signal timing device which sounds an alarm when the time period at the desired temperature has ended.

It is used wherever time at temperature is important, such as in heat treating, carburizing, tempering, cooling, or annealing processes.

For further information circle No. 26

ALLOY PROCESS EQUIPMENT

The Alloy Steel Fabrication Division of Aluminum and Architectural Metals Company, Detroit, Michigan, has available, upon request, a four-page-two-color folder on its job-proven fabricated carburizing boxes, trays, fixtures, fans, baskets, retorts, hoods and muffles. Generously illustrated, this folder well illustrates the wide versatility of basic design, development, engineering, and fabrication technique, available in present-day heat and corrosion-resistant alloy process equipment.

For further information circle No. 27

DRUM CLEANING

Fast, efficient removal of dirt, rust, paint and other foreign materials from drum exteriors, interiors and lids by Rotoblasting is described in a new four-page specification bulletin released by the Pangborn Corporation, Hagerstown, Md.

For further information circle No. 28

BOX FURNACES

The Hevi-Duty Electric Co., Milwaukee, Wisc., is offering a bulletin which gives complete information on their Multi-Range Box furnaces for hardening and tempering operations.

It is maintained that the wide temperature range of these furnaces together with precise control make these furnaces outstanding for achieving maximum high strength characteristics in steel parts that are heat treated in them.

For further information circle No. 29

INERT GAS GENERATORS

Two new bulletins on inert gas generators have been published by the C. M. Kemp Mfg. Co., Baltimore, Md. One gives technical and descriptive information on 500 and 1,000 CFH panel enclosed inert gas producers, and the other gives data on a new line of purge producers, designed for use where inerts are needed for blanketing, purging, and protective purposes.

For further information circle No. 30

DISSOCIATED AMMONIA

Armour Ammonia Division, Chicago, has published a booklet giving full details concerning the availability of their dissociated ammonia from 163 stock points and 8 bulk stations together with information concerning their technical services.

For further information circle No. 31

CLEANING OPERATIONS

A bulletin which describes the Waukee® Washer which matches a carbonitrider or carburizer is published by the Waukee Engineering Co., Milwaukee, Wisc. A hot detergent solution is sprayed through the work basket and washes away oil and foreign matter from a dense charge.

For further information circle No. 32

HEAT TREATING EQUIPMENT PROTECTION

Information is available from Arthur Tickle Engineering Works, Brooklyn, N. Y., concerning the use of a molten aluminum process on heat treating fixtures, trays, etc., to give them a longer life through added resistance to heat oxidation and corrosion.

For further information circle No. 33

PROTECTIVE COATINGS

The Markal Company, Chicago, Ill., is offering information and engineering service for special problems concerning carburization, decarburization and scaling during heat treating operations.

Their "C-R" coatings are claimed to protect up to 2100°F. stainless steels, titanium, zirconium, copper and other metals and alloys during heat treating processes.

For further information circle No. 34

HARDENING HIGH SPEED STEEL

The Sentry Company, Foxboro, Mass., has published a 12-page illustrated booklet which describes their line of electric furnaces and explains how the use of their Diamond Blocks as an inner furnace lining produces a neutral atmosphere required for hardening high speed steels without scale or decarb.

For further information circle No. 35

HYDROCARBON VAPOR ADSORPTION

A new 10-page illustrated brochure published by Selas Corporation of America describes how Selas Vape-Sorbers provide clean, dry air and gas for hospitals, pharmaceutical manufacturers, chemical manufacturers, food processors, petroleum refineries, steel plants, metal fabricators, instrument manufacturers, industrial gas manufacturers, bottling plants, ammonia plants, and users of pneumatic instruments and pneumatic tools.

The Bulletin announces the 14 standard sizes that are now available and explains in detail how the hydrocarbon vapor adsorption device protects air and gas systems and pneumatically-operated instruments and mechanisms from the effects of oil vapor, free oil, water-oil emulsions and dirt.

For further information circle No. 36

200-PAGE CATALOG AVAILABLE

A new, 200-page catalog illustrating and describing Blue M Electric Company's complete line of Electric Ovens, Furnaces, Baths, Environmental Cabinets, Related Temperature Control Equipment and accessories for laboratory, pilot plant and production facilities is now available.

A 16-page comprehensive Technical Section is incorporated in the catalog. Especially compiled to supplement the catalog descriptions which merely outline some basic or unique features of Blue M equipment, the Technical Bulletins are non-promotional but informative. The last pages are devoted to supplementary data such as scientific charts and tables which should prove to be useful and handy reference material.

For further information circle No. 37

GAS EQUIPMENT CATALOG

A completely new and unique catalog of "BUZZER" industrial gas burners, furnaces and accessories for heat treating, metal melting, soldering and drying has been issued by Charles A. Hones, Inc., Long Island, N. Y. The new booklet illustrates and describes the full Hones line, including sections on special furnaces and manual and automatic controls. After extensive laboratory and field research in manufactured, natural and liquefied petroleum gas ratings for its equipment, the company has developed highly accurate dimensional and BTU performance tables. Also, to assist in the proper selection of furnaces for their work capacity, Hones has included temperature curve and work rate charts with actual shop tests conducted under actual shop conditions with Strip Chart Recorders. The resulting data furnishes the buyer with a reliable method for pre-determining his heat range and equipment requirements.

For further information circle No. 38

INERT GASES

C. M. Kemp Mfg. Co. has published a bulletin on "How to Make Your Own Inert Gases." Their gas generators make the gases for many purposes including atmosphere protection during heat treatment.

For further information circle No. 39

INDUCTION HEATING EQUIPMENT

A 6-page bulletin published by General Electric pictorially shows the many gas, electric and induction heating equipments for various applications and processes.

The publication also contains an equipment index for different processes and complete listing of free bulletins on heating equipment available from the company.

For further information circle No. 40

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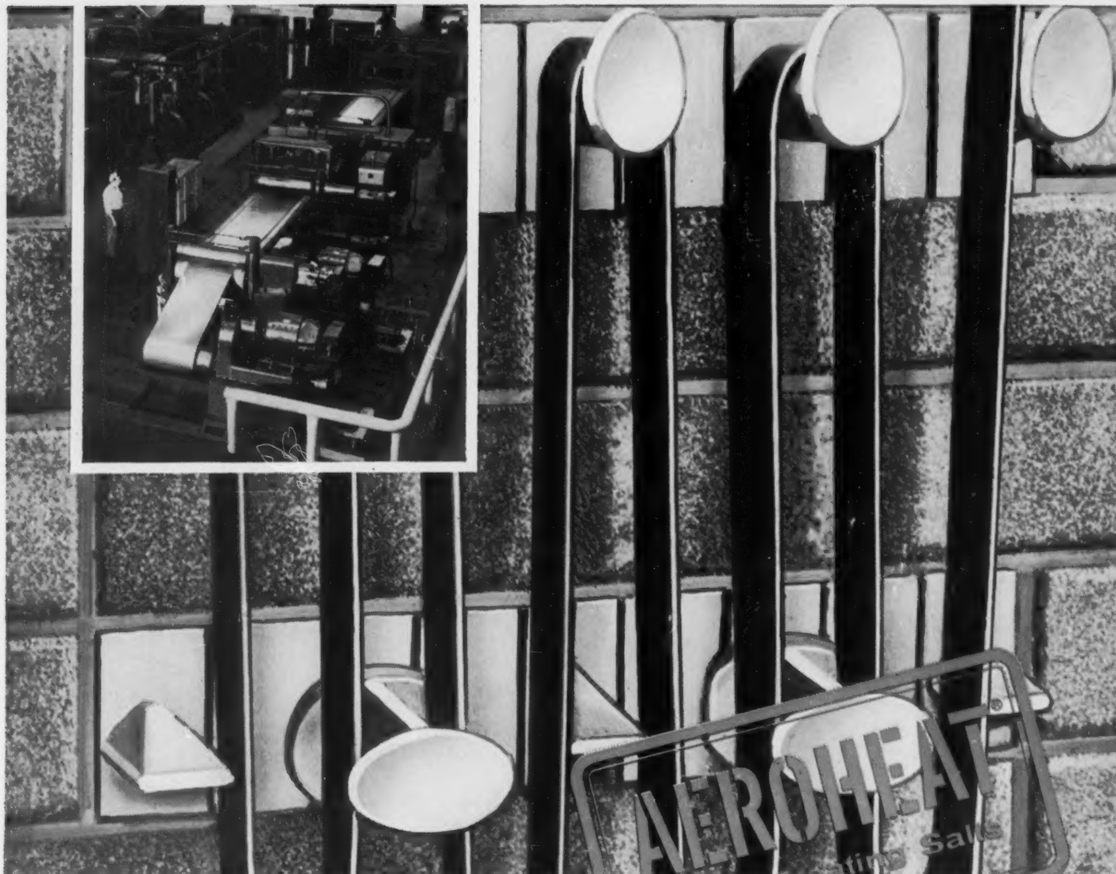

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Driver-Harris, for example, uses AEROHEAT 1400 in the manufacture of Nichrome† V, universally recognized as the outstanding heat-resistant and corrosion-resistant alloy. AEROHEAT 1400 plays a big part in giving Nichrome† V its exceptional uniformity, the ability to retain its physical and electrical properties at elevated temperatures, and the toughness to withstand the most punishing conditions.

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† T.M. Driver-Harris Co.

* T.M. Cyanamid

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